A MANUAL OF INDIAN BOTANY

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BY

G. C. BOSE, M.A.
Principal and Professor of Botany,
Bangabasi College, Calcutta

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FOREWORD

The textbooks of Botany commonly used in India are not exactly suited to the requirements of the Indian student. Most of the plants which they cite to illustrate the text are foreign to the plains of India, and serve no purpose other than to cram his memory with facts which he has no means to verify by actual observation. These textbooks naturally give prominence to those Natural Orders which prevail in Europe, while those of Indian importance find a scanty notice. Then again, there are many points of special interest in the Indian Flora which are either left out or treated in inadequate detail. It is hoped that the present Manual, by providing a book based upon Indian Natural Orders, will supply this real and long-felt want.

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PART I—MORPHOLOGY

CHAPTER I

INTRODUCTION

Plants grow all around us, and we have a general idea of what they are. We know that they are ordinarily fixed to the ground by means of roots which lie concealed therein; have aerial trunks or stems, short or long, branched or unbranched; and that the stems and branches bear green leaves of various forms and sizes. We also know that after a time these plants come to bear flowers, which gradually disappear, giving rise to fruits; that the latter when ripe contain within them seeds, and that these ripe seeds on falling to the ground germinate and produce young plants or seedlings which gradually grow into plants similar to their parents.

This is our general idea of the body of a plant and of the way in which it reproduces. The plant body, in fact, is seen to consist of roots, stems, leaves, flowers, fruits, and seeds. These members, or parts of a plant body, namely, roots, stems, leaves, flowers, fruits, and seeds, are seen to be used by the plant for two different purposes. By means of the roots, stems, and leaves a plant grows and thrives, whereas by means of flowers, fruits, and seeds it reproduces itself. So we may call the first three members of the

plant body NUTRITIVE or VEGETATIVE, and the other members REPRODUCTIVE.

Our general idea of a plant body, as described above, refers mainly to what are known as the higher classes of plants, with which we are more familiar. There are other plants, however, which belong to what are known as lower classes, with which we are less familiar. In these lower classes the plant body is not differentiated into members, such as roots, stems, leaves, &c., but consists of a uniform structure. Such a uniform undifferentiated plant body is known as a THALLUS, and all plants in which the body is a thallus are known as THALLOPHYTA or thallus-plants. For instance, the green **shaola** (*Spirogyra*) that floats freely in patches on the surface of many tanks, or the **shaola** (*Conferva*) (fig. 1) that is seen attached to the submerged masonry steps of bathing-ghats, consists of a mass of fine green branched or unbranched threads or filaments, each of which is a plant the body of which is not differentiated into root, stem, and leaf. **Shaola,** therefore, is a Thallophyte. Wet shoes, stale bread, stale curds, dung-cakes, &c., in the wet season are often found covered with a white or grey incrustation which consists of a network of fine

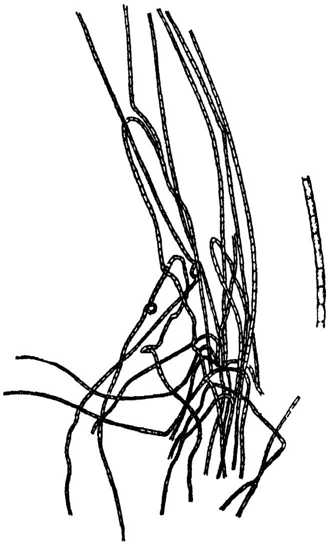


Fig. 1.—Shaola (*Conferva*)

threads. This network of fine threads is the body of a plant called **chhata** (*Mucor*) (fig. 2, *m*), which is perfectly undifferentiated, and thus belongs to the class Thallophyta. The higher plants with their body differentiated into roots, stems, and leaves, or only stems and leaves, are called by way of distinction CORMOPHYTA. It is with the Cormophyta mainly that we are concerned in this part of the book.

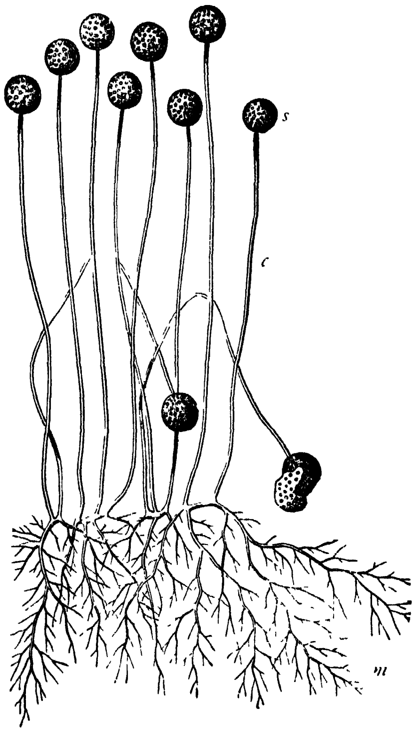


Fig. 2.—Chhata (*Mucor mucedo*)

m, Mycelium. *c*, Aerial hyphæ bearing sporangia *s* (highly magnified).

If we look round, we see that while a large number of familiar plants are TERRESTRIAL, that is, grow and live on land, others are either AQUATIC, that is, have no connection with the ground, but grow and live in water; or EPIPHYTIC, that is, grow and live attached to other plants as props or supports; or PARASITIC, that is, grow and live on other plants or animals, not merely as props or supports, but also derive their nourishment from them; or SAPROPHYTIC,

that is, grow and live on decaying animal or vegetable matter and get their food therefrom; or SYMBIOTIC, that is, grow in concert with other plants, and live a life of mutual help; or, lastly, INSECTIVOROUS, that is, live mostly on insects.

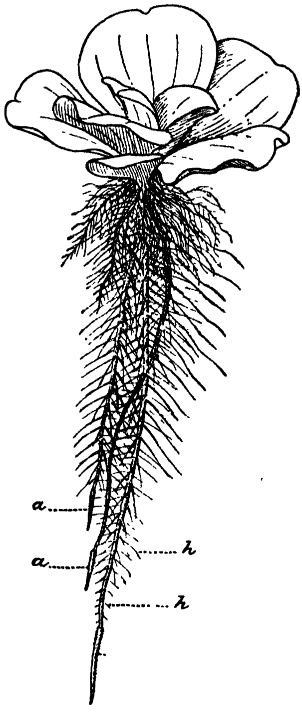


Fig. 3.—Pana (*Pistia Stratiotes*) showing root-caps (*a*) and root-hairs (*h*)

Of aquatic plants some float on the surface, as **pana** (*Pistia*) (fig. 3), or remain submerged, as **ganj** or **jhangi** (*Chara*), common **jhangi** (*Utricularia*) (see fig. 66), without being attached to any substratum; others have their roots, or roots and root-stocks, fixed to the mud and their stems or leaves, or both, floating on or sticking out of the water, as **padma** (*Nelumbium*), **shalook** or **shafla** (*Nymphæa*).

Most of the plants belonging to the Orchid family are epiphytes, as **rasna** (*Vanda Roxburghii*) (see fig. 265), a small herb often found attached by roots to the branches of Mango and other trees. Many **bot** or Banyan trees and **aswathwa** or Peepul trees germinate on **tal** or Palmyra-palms, **khejur** or Date-palms, and other trees, and remain epiphytic for years, until their roots, which creep on the surface of the prop-trees, strike the ground and make them terrestrial or land-

plants. **Gaja-pipul** (*Scindapsus officinalis*) (see fig. 267) is another good example of an epiphyte. It is terrestrial to begin with, but subsequently becomes detached from the soil and becomes wholly epiphytic. Several species of Ferns and Mosses also are epiphytes.

As examples of parasites may be mentioned **alak-lata** or **haldi-algusi** or Dodder (*Cuscuta*) (fig. 4), a thin, wiry, leafless plant, of whitish-yellow colour, often seen twining upon other plants and killing them by its luxuriant growth. It is also terrestrial to begin with, and becomes subsequently parasitic after being detached from the soil. Other examples are **Akas-bael** (*Cassytha*) (see fig. 244), similar to **alak-lata,** but greenish in colour; **bania-bau** (*Orobanche cernua* and *Orobanche indica*) (see Plate VIII, fig. B), which are parasitic on the roots of **begoon** or Brinjal and **tamak** or Tobacco, and are destructive to the crops; **barha-manda** and **chhota-manda** (*Loranthus*), a much-branched bushy plant that grows on Mango and other trees; **chandan** or Sandal-wood tree, a root parasite; various kinds of **chhata** or Fungi, which are parasitic on crops, and give rise to many plant-diseases (e.g. the potato disease) that often kill the plant.

Fig. 4 —Alak-lata or Dodder (*Cuscuta reflexa*)

Saprophytes are rare among higher plants. Some of the Orchidaceæ and several forest trees are wholly or partially restricted to a saprophytic mode of nutrition; but the Fungi amongst the Thallophyta afford some common examples of saprophytes, such as **banger-chhata** or Toadstool (fig. 5), which grows on dunghills, rotten timber, and straw; and common **chhata** or Mould (*Mucor*), which clothes the surface of stale curds, stale bread, wet shoes, dung-cakes, &c.

Fig. 5.—Banger-chhata or Toadstool

Symbiotic and insectivorous plants will be referred to in a subsequent section.

We have seen that ordinarily the body of a plant has four distinct members or parts, namely, root, stem, leaf, and flower. Of these members the root and the stem usually form a central axis, and leaves are attached to the stem as lateral appendages. The stem with its attached leaves goes by the name of the SHOOT.

The members of the plant body may be studied from two points of view: first, as to their mode of origin and development, their situation with respect to one another, and their external forms and internal structure; and, secondly, as to the functions which these members perform in the life-history of the plant. The study of a plant from the first point of view is known as MORPHOLOGY, and the study from the second point of view is known as PHYSIOLOGY.

From the point of view of physiology the members of a plant body may be divided, as already mentioned, into two heads, namely, VEGETATIVE and REPRODUCTIVE.

From the point of view of morphology they may be classified under three heads, namely, root, stem, and leaf. However much any member of the plant body may differ in form from any of these three types, it is ultimately reducible to one or other of them if we examine into the mode of its origin, development, and relative position. For example, the tendrils of **matar** or Pea; the scales which enclose the buds of **aswathwa** or Peepul tree, **bot** or Banyan, **kantal** or Jack-fruit tree, **kala** or Plantain, **kachu** (*Colocasia*); the two halves of the seeds of Pea and Gram or **chhola** which form our **dal**; the scales on **ada** or Ginger, the scales of **pianj** or Onion; and the petals and other parts of a flower, although they appear to be very different from leaves, are really modified leaves. Similarly, **aloo** or Potato, **kham-aloo** and **chupri-aloo** or Yams, **halood** or Turmeric, although they look like roots and grow under the ground like the latter, are really stems. The Radish or **moola**, Carrot or **gajar**, **sata-moolee** (*Asparagus racemosus*), Turnip or **salgum**, Beet (*Beta vulgaris*), **ranga-aloo** or Sweet-potato, **shank-aloo** (*Pachyrhizus angulatus*), **simool-aloo** or **kat-aloo** (Cassava), &c., which resemble Potato, Yams, &c., so much, are not stems, but real morphological roots.

CHAPTER II

THE SEED

Ordinarily plants are seen to spring from seeds. It would therefore be natural to begin the study of morphology with the examination of seeds.

First of all, let us take a **chhola, boot,** or Gram (fig. 6) and examine its parts. For the purpose of

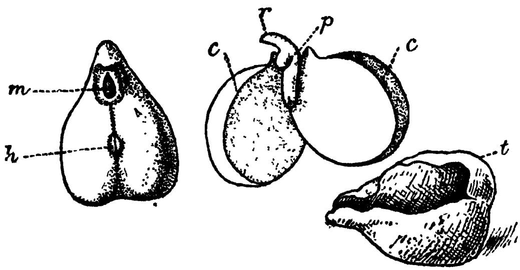


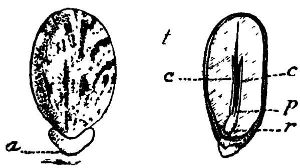
Fig. 6.—Chhola, Boot, or Gram Seed (*Cicer arietinum*)

m, Micropyle. *h*, Hilum. *t*, Testa removed. *c*, Cotyledons. *r*, Radicle. *p*, Plumule.

examination it would be convenient to take a **chhola** which has been kept soaked in water for about twelve hours. Externally the seed is pointed, and slightly bent at one end and rounded at the other. From the pointed end, along the concave side of the seed, there is a well-marked line. Just below the pointed end there is a prominent dark-coloured round pit, the micropyle (*m*), on the line, and farther down a dark-coloured scar, the hilum (*h*), on the same line. The scar marks the point where the seed was attached to the seed-vessel or fruit, and the pit marks the spot from which, as you will see presently, the primary root comes out on germination.

Peel off the brown coat, which is the covering or TESTA of the seed. The yellow structure thus exposed is the EMBRYO or the baby plant. On gently pressing the embryo, it separates into two thick fleshy halves; these are the seed-leaves or COTYLEDONS (*c*, *c*) of the embryo. On the face of one of the two cotyledons is seen a minute, yellow structure near the pointed end; this is the axis of the embryo, representing the axis of the future plant. The pointed end of this axis near the pointed end of the cotyledons is the RADICLE (*r*) or future root, and the opposite end of the axis is the PLUMULE (*p*) or future stem. The two cotyledons are hinged at the axis between the radicle and the plumule.

The radicle, plumule, and cotyledons together form the embryo of the seed. Thus **chhola** or Gram is a seed consisting of an embryo covered with a testa (*t*).



Whole Seed Section

Fig. 7. Rerhi or Castor-oil Seed (*Ricinus communis*)

a, Aril. *c*, Cotyledon. *p*, Plumule. *r*, Radicle. *t*, Testa.

But all seeds are not of this nature. Some contain within the testa an oily or mealy substance, called ENDOSPERM or albumen, in addition to the embryo. Take, for example, a **rerhi** (fig. 7) or Castor seed; it consists of a thin, linear, central embryo embedded in abundant oily endosperm, which is covered over with a dark-coloured horny testa.

Seeds like **chhola** are therefore said to be EXALBUMINOUS or without endosperm, whereas seeds like **rerhi** are said to be ALBUMINOUS or with endosperm. Examine the following seeds and make out whether they are albuminous or exalbuminous:

matar or Pea, **nebu** or Orange, **am** or Mango, **kantal-bichi** or Jack-fruit seed.

Examine next a grain of **dhan** or unhusked Rice (fig. 8). Superficially, you will find that the brown husk, which is easily separable into two halves, is

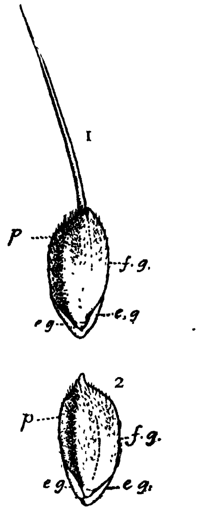


Fig. 8.—Dhan or Paddy Seed (*Oryza sativa*)

1, Awned. 2, Awnless. *p*, palea; *e.g.*, empty glumes; *f.g.*, flowering glume.

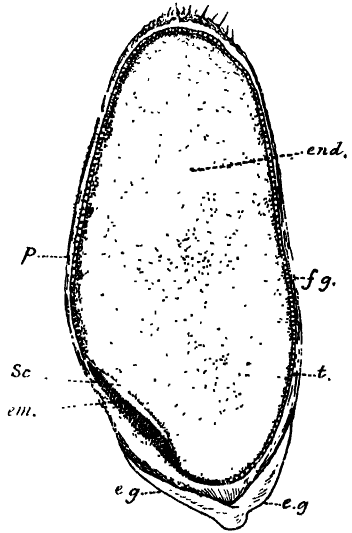


Fig. 9. Longitudinal Section of Unhusked Rice Grain

e.g., Empty glumes. *f.g.*, Flowering glume, *p*, Palea } husk. *em*, Embryo. *end*, Endosperm. *Sc.*, Scutellum. *t*, Testa.

embraced at one end by two minute white scales (*e.g.*), both of which are adherent to the husk. Then make a longitudinal section (fig. 9) of the grain. You will find inside the husk, and adjacent to the white scales (*e.g.*) referred to above, the obliquely-placed, minute embryo (*em.*) with the plumule, radicle, and only one cotyledon, and the rest of the space within the husk filled with a mealy endosperm (*end.*). The endo-

sperm, however, is distinctly separated from the embryo by a shield-like structure called the SCUTELLUM (*sc.*). In **dhan** the endosperm with the embryo forms the seed, and the testa or its covering is reduced to a mere thin white or reddish pellicle. The husk enclosing the seed is really no part of the seed, but is a case for protecting the seed. In fact, unhusked Rice is not a seed, but a fruit enclosing a seed within it. The structure of the grains of **bhutta** or Maize, **gahm** or Wheat, **job** or Barley, agrees in all essential respects with that of **dhan**. Note carefully the fact that all these seeds contain only one cotyledon in their embryo, whereas the seeds mentioned above, namely, Gram, Castor-seed, Pea, Mango, &c., contain two cotyledons in their embryo.

Plants have been divided into two big classes, called DICOTYLEDONS and MONOCOTYLEDONS, according as their seeds bear two cotyledons or one in their embryo. Speaking morphologically, this difference in seeds is fundamental, because the two classes of plants formed on this basis differ not only in the number of their cotyledons, but also in the structure of their roots, stems, leaves, and flowers, as will be seen later on.

CHAPTER III

THE SEEDLING

When seeds are sown, a young plant or seedling, is seen to come out of each of them. This is known as GERMINATION. In order to study the process of germination, sow Gram and Rice on a seed-bed and watch them day after day. In Gram the radicle

comes out first, through the pit mentioned in the last chapter, and begins to elongate and push its way downwards into the soil. Subsequently the plumule breaks its way through the testa and begins to elongate and grow upwards in the air. The radicle gives rise to the first or primary root, known as the TAP-ROOT, and the plumule gives rise to the first or primary stem or shoot, the two together forming the axis of the seedling. Soon the primary root, as it elongates downwards, gives off secondary or lateral branches from its sides in succession or ACROPETAL order. The primary stem also, as it elongates upwards in the air, gives off branches in acropetal order like the primary root; and, in addition, leaves on its sides, also in the same order.

In Rice the radicle does not elongate into a tap-root, but a number of thread-like roots burst out of it, forming a bunch known as a FIBROUS ROOT (fig. 10). The plumule also grows into a stem with leaves but no branches (fig. 11).

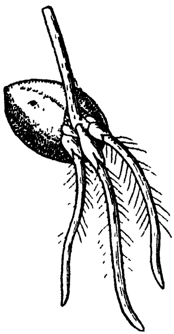


Fig. 10.—Sprouting Seed of Rice

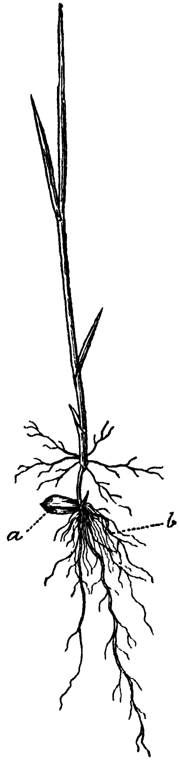


Fig. 11. – Oryza sativa
a, Germinating seed.
b, Fibrous root.

The mode of germination of the dicotyledonous seeds agrees in all respects with that of the Gram, and that of monocotyledonous seeds with that of

Rice; in other words, the former group of plants produces a tap-root, and the latter a bunch of fibrous roots.

If the seeds that have germinated are so placed that their roots point upwards and stems downwards, it will be found soon that the growing tips of the roots curve downwards and the growing tips of the shoots curve upwards, thereby assuming their normal position. The roots seem to have an innate tendency to grow down into the soil—avoiding light,—and the stems to grow up in the air—seeking light.

For purposes of germination, seeds require a suitable amount of heat, moisture, and air, and these conditions are ordinarily present in the soil. Too much or too little heat or moisture and absence of air in the soil prevent germination. Moreover, seeds require to be screened from light, as light retards germination, and this condition is secured in seed-beds. When these conditions are satisfied, the food materials stored in the seeds, either in the embryo or outside it, as the case may be, undergo chemical changes which render them soluble and available for the embryo. The embryo, thus nourished, grows into a seedling, as described above. In Pea, Gram, and dals or Pulses generally, the seedlings grow at the expense of the food materials stored in their thick, fleshy cotyledons. Hence it is that Pulses have been selected as food-grains by human beings all over the civilized world. As these cotyledons are hinged at the axis of the shoot of the embryo, the food materials pass directly from them to the shoot. In Rice, Wheat, Barley, Maize, and Cereals generally, the seedlings grow at the expense of the food materials stored in the endosperm. As the endosperm is situated outside the embryo, the cotyledon in these

seeds serves to absorb the food material from the endosperm and pass it on to the embryo. The Cereals therefore, like the Pulses, form a staple food of the major portion of mankind. Plants thus show a foresight, as it were, in providing a store of food in the seeds for the young seedling to grow at the expense of the stored food at the time of germination; the young seedling puts forth its roots first, so that it may absorb food from the soil, and from the food thus absorbed gradually build its stems, leaves, &c. By the time the seedling has grown, and is firmly established in the soil by means of its roots, the store of food in the seed becomes exhausted, the cotyledon or the endosperm shrivels up, and the plant begins to live on food absorbed from the soil by its own endeavours, and to lead an independent life of its own. To see the shrivelled-up endosperm, examine the germinating seeds of **tal** or Palmyra-palm, Cocoa-nut-palm, or Date-palm; to see the shrivelled-up cotyledons, examine the germinating seeds of Pea or Tamarind.

CHAPTER IV

THE ROOT

Roots usually have to make their way through the soil, in which considerable obstruction and resistance await them. Their young, growing, delicate tips are therefore provided with a layer of protective tissue which is known as the ROOT-CAP. Behind the region of the root-cap, the growing root for some distance is furnished with close-set fine delicate hairs known as

ROOT-HAIRS, which, entering into the finest interstices of the soil, anchor the plant firmly into it. The root-hairs further serve the purposes of absorbing water from the soil, and of secreting a mucilaginous substance which facilitates their passage through the soil, and an acid juice which renders otherwise insoluble and therefore unavailable food-materials in the soil soluble and available to plants.

To find root-caps and root-hairs, examine the tips of the roots of Banyan (fig. 12) that hang in air or spread upon the surface of a wall or of a tree; the tips of the stilted aerial roots of **kia** or Screw-pine (*Pandanus fascicularis*); the roots of **pana** (see fig. 3), **khudi-pana** or Duck-weed (*Lemna*) (fig. 13), &c.

Fig. 12.—*a*, Root-cap of *Ficus bengalensis* (bot). *a'*, Cap enlarged

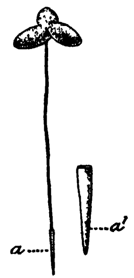


Fig. 13.—*a*, Root-cap of Khudi-pana or Duckweed (*Lemna trisulca*) *a'*, Cap enlarged.

The tap-roots during growth assume various forms; thus they are FUSIFORM (fig. 14, A, B), as in Radish, Carrot, **palang** or Spinach (*Spinacia oleracea*); NAPIFORM (fig. 14, C), as in Turnip, Beet; or BRANCHED so that the distinction between the primary root and its lateral branches becomes obliterated, as in most woody Dicotyledonous trees. Fibrous or bunch-roots may remain thin, as in Onion, or they may become thick or TUBEROUS (fig. 14, D), as in **sata-moolee, ranga-aloo, shank-aloo.**

Roots, as has been described above, develop from the radicle. Often, however, they are seen to originate from parts other than the radicle, such as stems,

leaves, or other parts of plants. Such roots are said to be FALSE or ADVENTITIOUS as opposed to TRUE or RADICULAR roots. One of the best examples of false

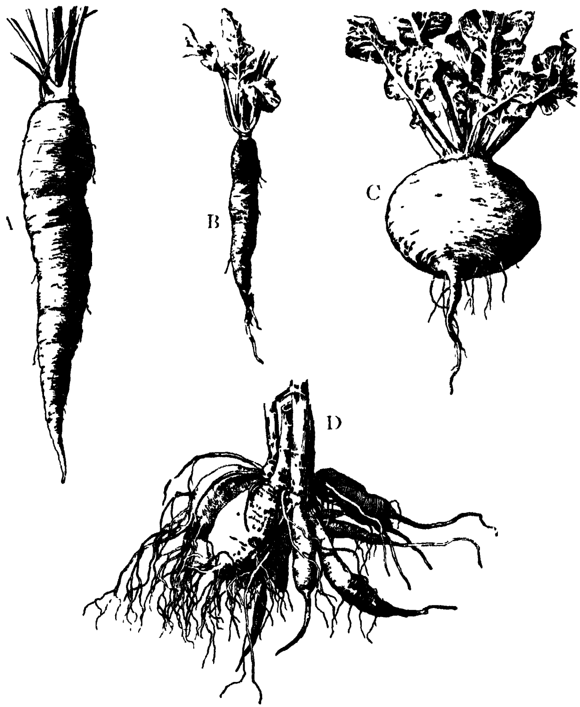


Fig. 14.—Tap-roots

A. Carrot or Gajar, and B, Radish or Moola (fusiform). C, Turnip or Salgum (napiform). D, Tuberous root.

roots is afforded by the Banyan tree, the branches of which produce roots which for some time remain suspended in the air till they reach the ground and penetrate the soil; **kia** (fig. 15) is another common example. The leaves of **pathar-kucha** or *Bryo-*

phyllum, of **him-sagar** or *Kalanchoe*, and of *Begonia* are often seen to develop such adventitious roots.

Roots usually grow underground, and serve to fix the plant to the ground, so that the plant may not be

Fig. 15.—The Screw-pine or Kia, with stilted Roots growing from the Stem

at the mercy of the winds and the waves. But there are roots which are AERIAL, that is, which grow and live in the air without any contact with the soil. Most of the Orchids (fig. 16) germinate on branches of trees, and remain clinging to them by the aerial roots.

Most climbing plants produce from their stems adventitious roots, by means of which they remain attached to their supports, as, for example, **gaja-pipul** (see

Fig. 16.—Orchid growing on a Tree, showing Aerial Roots

fig. 267), **gachh-pan** (Piper), **chai** (Piper). The aerial roots of Banyan, Screw-pine, Maize, **tal**-palm, and other palms also serve as good examples.

Many water-plants usually spread their roots in water without attachment to any substratum, as in

Pistia (see fig. 3), Duckweed (see fig. 13), **patari** (*Limnanthemum*), **pan-phal** or Water-chestnut, &c.

In the Sundarbans, where the soil is water-logged, trees such as the **sundri** (*Heritiera minor*), the Mangrove, &c., develop special roots which, instead of going down and spreading under the soil, rise from the soil with their tips out into the air. These aerial roots are provided with a scabrous bark full of groups of air-holes, called LENTICELS, through which the roots are aerated. Such roots are therefore known as BREATHING-ROOTS. This is an instance of special adaptation often seen in plants to meet special circumstances. Plants like **kia** or Screw-pine give off aerial roots from the lower parts of their stems, which ultimately strike into the ground and support the stem like stilts, hence such roots are called STILTED ROOTS.

Plants like Dodders, *Cassytha*, *Loranthus*, *Orobanche* (see Plate VIII, fig. B), which are parasites, send their roots into the body of their host, and live by sucking its juice by these roots. Such roots are therefore called SUCKERS or HAUSTORIA.

Thick fleshy roots like those of Radish, Carrot, Sweet-potato, **shank-aloo**, &c., are the storehouse of food reserved by plants for their own use in future. Sweet-potato and **shank-aloo** plants are propagated mainly by these thick roots. Plants like Radish and Carrot, which are *biennial* in cold climates, store up food in their roots during the first season of their growth, so that they may put forth flowers, fruits, and seeds at the expense of that reserved food during the second season of their growth. The last-named plants in warm countries like India are *annuals*, and the food-materials stored up in their roots in the early part of their growth are used up later in the year for

the growth of flowers, fruits, and seeds. It is for this reason that these plants are harvested for our use before they run to flower and seed. If they are allowed to run to flower and seed, they become unfit for human consumption, their store of food being used up by the plants themselves.

CHAPTER V

THE STEM

The stem is the direct prolongation of the plumule of the embryo, and usually grows upwards above the ground. It differs from the root not only in the direction of its growth but also in several other respects; thus it bears leaves on its sides while the root bears no leaves, its growing apex is not covered by a protective tissue or cap like that of a root, and the region of it just behind the growing apex is not provided with hairs as is that of a root.

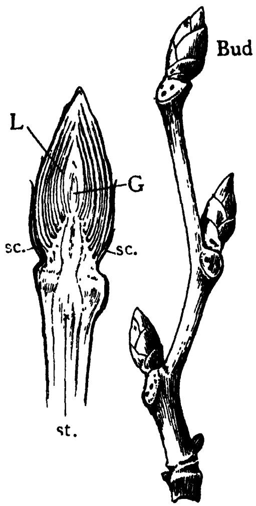


Fig. 17.—Stem with Buds, and Section of Bud

G, Growing point. L, Leaves. *st*, Stem. *sc*, Outer scale leaves.

The growing apex of the stem is the continuation of the plumule, and consists (fig. 17) of a central axis covered over and protected by a crowd of young and folded leaves. The growing apices of both stems and roots are delicate, and therefore require protection. In the case of roots the

apices have to make their way through the soil, which is a more resisting medium than the air through which the apices of stems have to make their way. Hence the former have a strong protective tissue in the form of a cap, while the latter have a few leaves to perform the same function. In cold countries, where plants have to pass through a rigorous winter, the growing apices of stems to meet this special circumstance are further covered by special leaves known as BUD-SCALES, on the outside of the ordinary leaves (fig. 17, *sc*). In warm countries, like India, such protective scales are occasionally met with, as in Banyan, Peepul, rubber or India-rubber, and Jack-fruit trees.

The growing apices of stems with their crowds of young leaves are known as BUDS, and as these buds terminate or stand at the apex of the stem, they are said to be TERMINAL. Further, each leaf usually bears in its AXIL, that is, the inner or upper angle which it makes with the stem, one bud. Such buds are AXILLARY OR LATERAL as they stand in the axil of the leaf or on the side of the stem, and they develop, like leaves, in acropetal order. The stem elongates by the growth of the terminal bud, and branches by the growth of the lateral buds. When the axillary buds remain undeveloped, the stem becomes branchless, as in Palms. In some plants some of the axillary buds remain undeveloped for a time and grow subsequently when necessity arises; such buds are said to be sleeping or DORMANT.

The axillary buds, as described above, grow in the axils of leaves in acropetal order. Buds, however, occasionally arise from other parts of the stem or from roots or even from leaves in any order. Such buds are therefore said to be ADVENTITIOUS. For example,

the roots of **patal** (*Trichosanthes dioica*) produce such buds, and the plants are usually propagated by cultivation from them. Similarly, the leaves of **pathar-kucha** (*Bryophyllum*) (see fig. 126) and **him-sagar** (*Kalanchoe*) give rise from their margin to adventitious buds which grow into plantlets. Truncated trees are often seen to put forth new shoots, and these shoots mostly spring from adventitious and dormant buds. Date-palms are usually branchless, but occasionally they are found with two or more heads, and these heads are due to the growth of dormant axillary buds. Normally only one bud is produced in the axil of each leaf, and the production of more than one bud from the same leaf-axil may be taken as exceptional.

Although the majority of plants develop their stems in air, there are some in which the stems live and grow under the ground, and are therefore popularly mistaken for roots. But, like aerial stems, they are provided with leaves and buds, and have all the morphological characters of a stem, though they may look like roots and have root-like environment. The leaves of these underground stems are never green, like ordinary leaves, and are often very small; hence they are known as scale leaves, or simply SCALES. The buds in the axils of these scales usually give rise to annual aerial shoots which unfold green leaves, put forth flowers, fruits, and seeds, and then die down to the ground, leaving the perennial underground stem to grow under the ground and repeat year after year the production of aerial annual shoots, &c. Such underground stems or their scales are usually thick and swollen, with an abundant store of nutrient materials which serve to feed the annual shoots described above. Plants with underground stems are therefore usually propagated in cultivation not from seeds but from

underground stems. The storage of food in seeds, in thick, fleshy roots, and root-like stems are all instances of foresight of plants to provide for their future

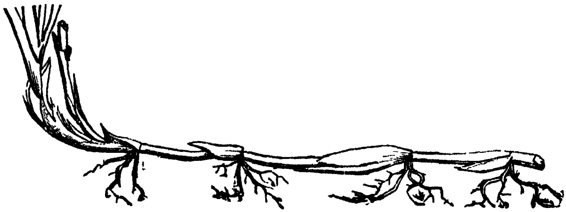


Fig. 18. A Rhizome or Root-stock

wants. The reservoirs of food contained in such parts of plants form our principal food materials.

The underground stems take different forms in different plants. When they are long and grow more or less horizontally, dying at one end and growing at the other, they are known as RHIZOMES or ROOT-STOCKS, as in **ada** or Ginger, **halood** or Turmeric, **shalook** (*Nymphæa*), **padma** or Lotus, **kala** or Plantain, several Grasses and Sedges or **mootha**-like grasses (fig. 18). Occasionally the rhizomes are short, grow more or less vertically, and the top portion rises partially out of the ground, as in

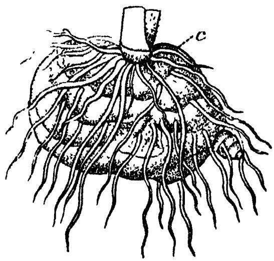


Fig. 19.—Corm (*c*) of Ol (*Amorphophallus campanulatus*)

man-kachu (*Alocasia*). When the underground stem is thick and trunk-like in form, with minute scattered scale leaves and prominent buds, it is known by the name of CORM, as in **ol** (*Amorphophallus*) (fig. 19). Thickened and more or less rounded underground stems, like Potato (fig. 20), **mootha** (*Cyperus rotun-*

dus), **keshur** (*Scirpus grossus*), are known by the name of TUBER. In fact, tubers are swollen underground branches or parts of branches. They bear on them buds known as "eyes". These eyes develop into aerial shoots during the following season. BULB is the name given to that kind of underground stem

Fig. 20.—Potato Plant or Aloo, showing Tubers

which is really a thickened underground bud. It consists of a small slightly convex disk-shaped stem closely invested by large and overlapping fleshy scales in which food-materials are stored. Small bulbs or bulblets are present in the axils of some of the scales. In the growing season the short disk grows into an aerial flowering shoot. Onion (fig. 21), **rasun** or Garlic, **rajani-gandha** or Tuberose (*Poly-*

anthes tuberosa.), are some of the familiar examples of bulb. The bulblets mentioned above often separate from the

Fig. 21.—Onion or Pianj (Bulb)

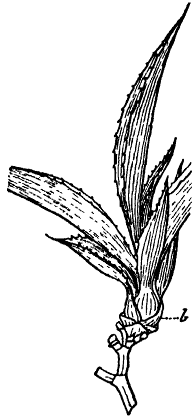


Fig. 22.—Agave (*Cantula*), a kind of murga

b, Bulbil.

parent bulb, and give rise to new plants, which produce new bulbs. Underground stems are more

Fig. 23.—Globba bulbifera

f, Flowers. *b*, Bulbils from flower-buds. *b'*, A bulbil enlarged.

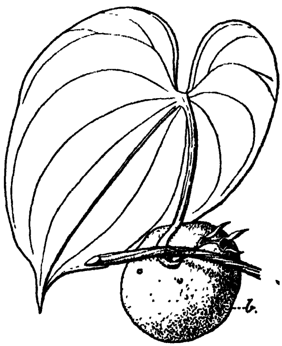


Fig. 24.—Dioscorea bulbifera (Chuprhi-aloo)

b, Bulbil.

common among Monocotyledons than among Dicotyledons.

The axillary buds of several aerial stems naturally separate from the axils of the leaves, and, falling to the ground, grow and reproduce the plant just as the bulbs do. Hence these aerial buds are known as aerial BULBILS. The flowering shoots of *Agave cantula*, a kind of **murga** (fig. 22), *Globba bulbifera* (fig. 23), as well as the twining stems of **chuprhi-aloo** or Yam (*Dioscorea*) (fig. 24), are familiar examples of the detachment of bulbils.

CHAPTER VI

THE STEM (*Continued*)

Stems are usually marked on their surface with more or less conspicuous rings called NODES. They are very prominent in the stems of Bamboo, Sugar-cane, Maize, Betel-nut (**supari**), Palms, &c. Portions of stems between successive nodes are called INTERNODES, which are short or long according to the kind of plant. Absence of nodes in roots is another morphological difference between them and stems. In some plants a portion of the axis which lies between the cotyledons above and the real root below bears the mixed character of both root and stem. This portion of the axis is known as the HYPOCOTYL or region below the cotyledons. If we examine a Tamarind seedling, we find that the pair of thick cotyledons, instead of remaining under the ground during germination, as in most seeds, are carried above the ground by the growing axis. Here the hypocotyl, or the portion of

the axis between the cotyledons and the real root, is very marked.

Of the aerial stems some are strong enough to stand erect, while others are too weak to do so. If the stems of the latter kind fell down in a heap, confined within a very small area, it would be impossible for the plants to develop their organs, especially the leaves, in a manner suitable to their requirements of growth and life. Hence weak-stemmed plants either trail along the ground or climb upon other standing plants or supports, as by these means they are able to develop their leaves apart from one another, and in a manner suitable to the requirements of healthy growth and life.

The trailing stems are either PROCUMBENT, that is, they run along the ground and do not root at the nodes, or CREEPING, that is, they extend along the ground and root at the nodes. **Puin** or *Basella* is an example of the former, and **durba-ghas** or *Cynodon Dactylon* (see fig. 274) and **ranga-aloo** or *Ipomœa Batatas* of the latter. Creeping stems often run along the ground from one end of a field to the other, and produce erect shoots at their nodes, and these latter sometimes separate from the creeping stems, start an independent life of their own, and develop creeping stems for themselves. Such creeping stems are called RUNNERS (fig. 25) or STOLONS, and their erect shoots OFFSETS, as in **thulkuri** (*Hydrocotyle*) and **shushuni-shag** (*Marsilea*) (see fig. 50). The runners or stolons are sometimes underground, as in *Cyperus rotundus* and **durba-ghas**; in fact, rhizomes are underground runners.

The climbing plants adopt several contrivances for the purpose of raising themselves upon other plants or supports, so as to spread their leaves to the sun and prevent their overcrowding. For example, plants

like **shim** (*Dolichos*), **barbati** (*Vigna Catjung*), **golancha** (*Tinospora cordifolia*) (see fig. 149), climb by TWINING or twisting their stems round the support like the threads of a corkscrew; plants like **shasha** or **khira** (*Cucumis sativus*), **matar** or Pea, **lau** or **kadoo** or Bottle Gourd (*Lagenaria vulgaris*), climb by the help of thread-like structures known as tendrils; plants like **gaja-pipul** (see fig. 267), **pan** or Betel Vine (*Piper*

Fig. 25.—Creeping Stem or Runner

Betel), climb by the help of adventitious roots coming out of the stem and clinging to the support; plants like **bet** or Cane (*Calamus*), **munjishtha** (*Rubia cordifolia*), **kantali-champa** (*Artabotrys*), **bengchi** or **bonch** (*Flacourtia Ramontchi*, L'Herit., var. *sapida*), **shia-kul** (*Zizyphus*), climb by means of spines or hooks; plants like *Clematis* (see fig. 144), Garden Nasturtium (*Tropæolum majus*), and **isher-mul** (*Aristolochia indica*) climb by twisting their leaf-stalks; and plants like **ulat-chandal** (*Gloriosa superba*) climb by their spirally-wound leaf-apices (see fig. 249). Among twining plants some are DEXTRORSE, or coil towards the right or clock-wise, as **chuprhi-aloo** (*Dioscorea*); and some

are SINISTRORSE, or coil towards the left or counter-clock-wise, as **kalai** (*Phaseolus*), **shim** (*Dolichos*). The latter are more common than the former. The direction of the spiral is generally constant in any given kind of plant. For instance, all *Ipomœa* and all *Convolvulus* are sinistrorse, whereas all *Dioscorea* are dextrorse. A very few plants seem able to climb equally well either way. Dense tropical forests of lowland river-basins consist of giant trees to whose tops gigantic woody climbers called LIANAS rise and run along from one end of the forest to the other, forming loops and wreaths. Common lianas of Bengal are **madhabi-lata** (*Hiptage Madablota*) and several species of **kanchan** (*Bauhinia*).

Stems are usually more or less round in outline, that is, their transverse sections are more or less circular. The following noticeable divergences from this type are, however, common: for example, in **tulsi** (*Ocimum*), **ghal-ghase** (*Leucas aspera*), and most plants of the **tulsi** family, the stems are square, while in **madurkati** (*Cyperus tegetum*), **mootha** (*Cyperus rotundus*), and other Sedges, they are triangular.

Plants that live for a year, or rather a season, are known as ANNUALS, or season plants, as are most of our field-crops, like Rice, Mustard, Jute, Radish, &c. Those that live for two years are known as BIENNIALS. Plants that live for a number of years are known as PERENNIALS.

Plants are usually classified into herbs, shrubs, or trees. The annuals, the biennials, and most of the plants with underground perennial stems are herbs. Most of the herbs have soft tissues; in fact, the term HERBACEOUS is used with respect to any plant or part of a plant which consists of soft tissues, whereas the term WOODY is used with respect to any plant or part

of a plant with hard and woody tissues. Plants with a single woody trunk of a large size, which usually branches higher up, or sometimes remains unbranched, are known as trees; whereas shrubs are low dwarf trees, or woody plants, with several stems from the same root. The terms CULM and HAULM are often used in speaking of the stems of Grasses, and CAUDEX in speaking of the unbranched stems of Palms.

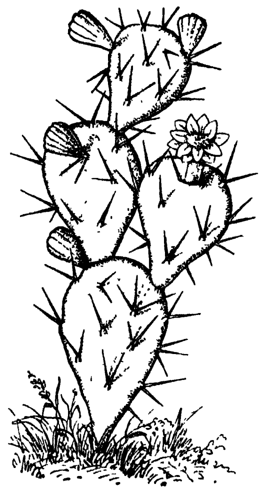


Fig. 26.—Prickly Pear or Phani-monsha (*Opuntia Dillenii*)

In some plants the stem becomes flattened out somewhat like a leaf, and is green like the latter. Such leaf-like stems are known as CLADODES. One of the best examples commonly met with in gardens is *Cocoloba platyclada* (Plate I), in which the stem is flat like a ribbon, and of a shining green colour. That it is not a leaf but a true stem is evident from the following considerations, namely, that it is divided like a stem into distinct nodes and internodes; that it bears, when young, small leaves on its margins, which, however, fall off as the stem develops; that the surfaces look sideways, instead of up and down as in leaves; and that both the surfaces are equally green, in other words, one surface is not deeper green than the other, as in leaves. Cladodes are homologous with stems but analogous with leaves. Another common example of a Cladode is **nag-phani** or **phani-monsha** (*Opuntia Dillenii*) (fig. 26). Several species of Cactus and **siju** (*Euphorbia*) are more or less of this nature.

CHAPTER VII

THE LEAF

Leaves are lateral appendages of the stem, and grow in an acropetal order. The leaves of the embryo are known as cotyledons, the leaves of the underground stem as scales, the ordinary green leaves of the aerial stem as foliage or vegetative leaves, and the leaves of the flower, such as petals, &c., as floral or reproductive leaves. In this chapter we shall deal with foliage leaves only, and these latter are what we commonly call leaves.

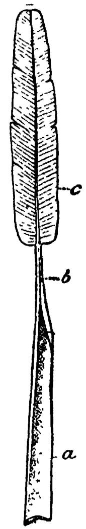


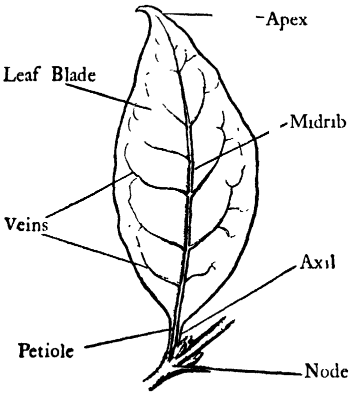
Fig. 27.—Plantain Leaf: Kala pata

a, Sheath. *b*, Petiole. *c*, Blade.

A typical leaf consists of a flat broad portion, the BLADE or LAMINA, situated at the top of a thin elongated portion, the PETIOLE or STALK, the base of which broadens out into a SHEATH, which partially or wholly embraces the stem. Take, for instance, a Plantain leaf (fig. 27). It has a large oblong blade, a long petiole, and a long, broad, concave sheath, the sheaths of the leaves collectively forming the so-called stem of the plant. Most of the Monocotyledons have leaves with sheathing bases, as, for example, Palms (**tal, narikel, khejur, supari**, &c.), Grasses (**bans** or Bamboos, **akh** or Sugar-cane, **bhutta** or Maize, **durba**, &c.), Arums (**kachu, man-kachu**, &c.), Ginger, Turmeric, &c. Among Dicotyledons most of the *Umbelliferæ*, such as **dhania** or Coriander (*Coriandrum sativum*), **mouri** or Fennel (*Fœniculum vulgare*), **juan** (*Carum cop-*

ticum), &c. *Ranunculaceæ* and *Dilleniaceæ* (chalta) have often sheathing leaves.

The majority of the leaves, however, have only the blade and the petiole, and not the sheath (fig. 28). A small minority have the blade only, and neither the petiole nor the sheath. In Grasses the leaves have usually blade and sheath, but no petiole, or hardly any. Leaves with petiole are called PETIOLATE, and leaves without petiole SESSILE. In fact, the word sessile is used to designate all structures that are not provided with a stalk. Leaves with a very short petiole are often described as SUBSESSILE or SUB-PETIOLATE. It should, however, be remembered that leaves that have no petiole, but a sheath, as those of most Grasses, are not sessile, because in such cases the blades are not inserted directly on the stem, as the blades of true sessile leaves are.



Fi 28.—Diagram to Illustrate Parts of a Leaf

A leaf-blade, which for convenience is often designated shortly as a leaf, should be examined with regard to its form, margin, apex, base, venation, surface, and consistency. The form may be described in ordinary English, but it would be more convenient to use the following technical terms, namely: (1) ORBICULAR (fig. 29) or round, as in padma (*Nelumbium*); (2) LINEAR or long, as in most Grasses; (3) LANCEOLATE or lance-shaped, as in Bamboo; (4) ELLIP-

TICAL, as in **golap-jam** (*Eugenia Jambos*); (5) OBLONG, as in Plantain; (6) OVATE or egg-shaped, as in

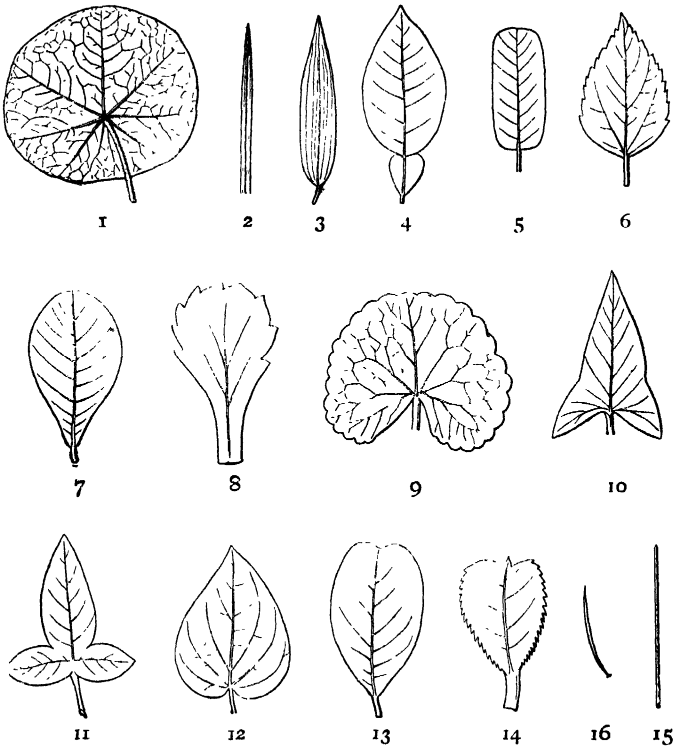


Fig. 29. Shapes of Leaves

1, Orbicular. 2, Linear. 3, Lanceolate. 4, Elliptical. 5, Oblong 6, Ovate. 7, Obovate. 8, Spathulate. 9, Reniform. 10, Sagittate. 11, Hastate. 12, Cordate. 13, Obcordate. 14, Cuneate. 15, Filiform. 16, Subulate.

Banyan; (7) OBOVATE or ovate reversed, as in **deshi-badam** (*Terminalia Catappa*); (8) SPATHULATE or spatula-shaped, as in *Drosera Burmanni*; (9) RENIFORM or kidney-shaped, as in **thul-kuri** (*Hydrocotyle*

asiatica); (10) SAGITTATE or arrow-shaped, as in *Sagittaria sagittifolia*; (11) HASTATE or dart-shaped, as in **kalmi-sag** (*Ipomœa reptans*) and **ghet-kachu** or **ghekul** (*Typhonium trilobatum*); (12) CORDATE or heart-shaped, as in **pan** (*Piper Betle*); (13) EMARGINATE, OBCORDATE or cordate reversed, as in **kan-**

Fig. 30.—Repand Leaf (debdaru) —(*Polyalthia longifolia*)

chan (*Bauhinia*); (14) CUNEATE or wedge-shaped, as in **bara-pana** (*Pistia Stratiotes*); (15) ACEROSE, FILIFORM, or thread-like, as in **chir** and **saralgacch** (*Pinus Khasya*); (16) SUBULATE or awl-shaped, as in **belati-jhau** (*Thuja*).

The margin of a leaf is said to be ENTIRE when it is not at all indented or cut, as in Mango; and REPAND when it is entire but wavy, as in **debdaru** (*Polyalthia longifolia*), (fig. 30). If the margin is slightly indented it is said to be CRENATE when the

indentations or teeth are rounded at their apices, as in **beng-chi** (*Flacourtia*), **pathar-kucha** (*Bryophyllum calycinum*); DENTATE when the teeth are pointed and not directed either towards the apex or the base of the leaf, as in **rakta-kambal** (*Nymphæa rubra*); SERRATE when the pointed teeth are directed towards the apex of the leaf, as in **jaba** (*Hibiscus rosa-sinensis*), (fig. 31); RETRO-

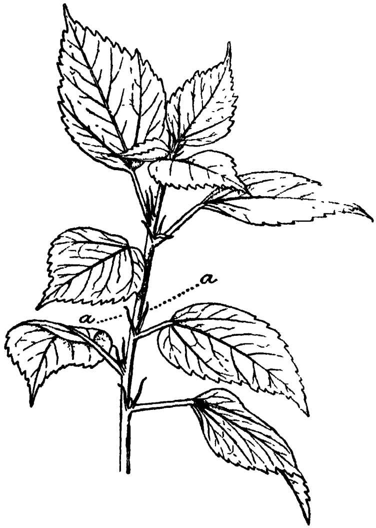


Fig. 31.—Serrate Leaves of Jaba or Chinese Rose (*Hibiscus rosa-sinensis*)

a, a, Lateral stipules.

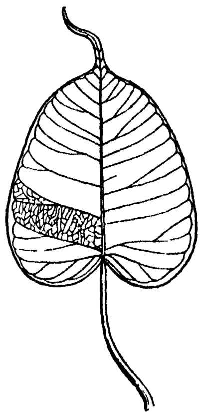


Fig. 32.—Acuminate Leaf of Peepul (aswathwa) (*Ficus religiosa*)

SERRATE when the teeth are directed towards the base of the leaf (see fig. 29, 14).

The apex of a leaf is said to be OBTUSE when it is rounded and blunt, as in Banyan; ACUTE when it is pointed, as in Mango; ACUMINATE or CAUDATE, when it is pointed and long, as in Peepul trees (fig. 32); EMARGINATE when instead of being pointed it is indented, as in the leaflets of **amrul** (see fig. 50); MUCRONATE (see fig. 29, 14), when the obtuse apex

ends in an abrupt point, as in the leaflets of many *Cassia* (**kalkasonda**); and CUSPIDATE when the acute apex is spiny, as in Pine-apple (**anaras**) and *Pandanus* (**kia**).

In a sessile leaf the base of the blade may be prolonged into two ear-like lobes, which partially or wholly clasp the stem. Such leaves are called AURICULATE (fig. 33) or AMPLEXICAUL (fig. 34), according as the clasping is partial or complete. If the two lobes be united

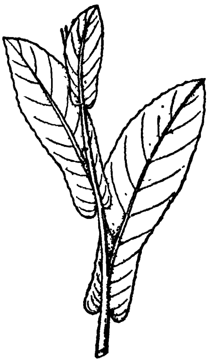


Fig. 33.—Auriculate Leaf

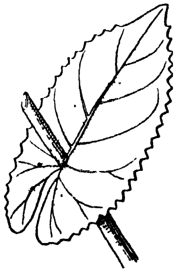


Fig. 34.—Amplexicaul Leaf

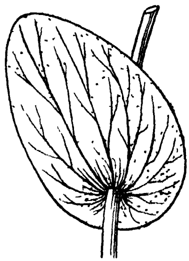


Fig. 35.—Perfoliate Leaf

together on the side of the stem opposite to the insertion of the leaf, the leaf is said to be PERFOLIATE (fig. 35). If two opposite auriculate leaves unite by the lobes of their bases so that the stem seems to pass through the middle of the united blades, the leaves are said to be CONNATE (see fig. 211).

If a blade be examined, it is found that the soft structure of it is traversed by stiff threads, which are called VEINS or ribs or nerves (see fig. 33). The arrangement of veins in a blade is termed VENATION. The venation is classified into four types, namely: PINNI-VEINED, PALMI-VEINED, PARALLEL-VEINED, and

CURVI-VEINED. In pinni-veined leaves (see fig. 28) the blade is traversed by a long thick central vein called the MID-RIB, which divides the blade into two equal halves, and is the continuation of the petiole. From the mid-rib on either side of it a number of thinner secondary veins are given off, which proceed towards and terminate near the margins. These secondary veins are like the feathers or pinnæ of a quill, and hence the venation has been styled pinni- or feather-veined. When the mid-rib divides the blade into two unequal parts, the leaf is said to be UNEQUAL or unsymmetrical, as in *Begonia*. Unequal leaves are not very common.

In palmi-veined leaves (see fig. 167) there is not one principal or central mid-rib continuous with the petiole, but a number of stout ribs radiate from the base of the blade towards its margin, as if the petiole had split up into so many branches on entering the blade. The radiating veins look like the outstretched fingers of the human palm, from which resemblance the name palmi-veined originates. In parallel-veined leaves (see fig. 22) the blade is traversed by a number of veins nearly parallel to the mid-rib. Sometimes these veins are more or less curved, then the leaf is said to be curvi-veined (see fig. 24). The majority of Monocotyledons are parallel-veined, whereas the majority of Dicotyledons are pinni-veined or palmi-veined. Curvi-veined leaves are comparatively few, as **tezpat** (*Cinnamomum Tamala*), **dalchini** (*Cinnamomum zeylanicum*), **kappur** (*Cinnamomum Camphora*), **kul** or **baer** (*Zizyphus Jujuba*), **kuchila** (*Strychnos Nux-vomica*), **nirmalli** or Clearing-nut (*Strychnos potatorum*), *Osbeckia*, *Melastoma*, *Dioscorea* (see fig 190; Plate IV, fig. A; and fig. 24).

In Dicotyledons the principal veins, as a rule,

branch repeatedly into smaller and smaller veins; which latter, anastamosing or uniting with one another, form a network, as in Peepul, Mango, Banyan, &c. Such leaves are described as RETICULATE or net-veined. In Monocotyledons, on the other hand, the minor veins do not, as a rule, form a network, hence such leaves are described as NON-RETICULATE. In **kala-jam** (*Eugenia Jambolana*),

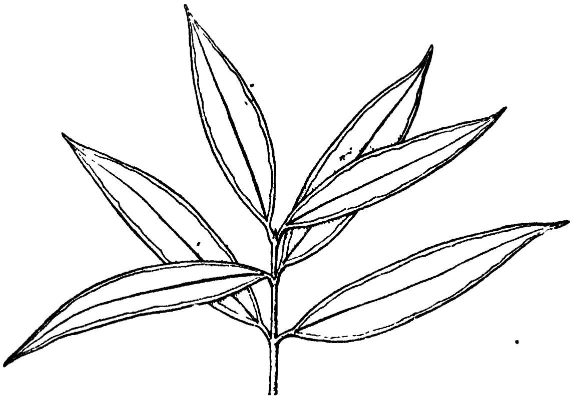


Fig 36.—Dotted Leaf with Sub-marginal Vein—Golap-jam (*Eugenia Jambos*)

golap-jam or Rose-apple, and similar other plants, there is a sub-marginal vein in each half of the blade (fig. 36).

The margin of a leaf may be entire or slightly indented, and the nature of such margins has been described. If, however, the margin is deeply indented, each segment of the blade is termed a LOBE, and the whole leaf is said to be LOBED. Lobed leaves of the pinni-veined type are termed PINNIFID, PINNIPARTITE, and PINNISECT (fig. 37), according to the depth of the indentations. Lobed leaves of the palmi-veined type are similarly termed PALMIFID,

PALMIPARTITE (fig. 38), and PALMISECT. When the outer lobes of a palmi-lobed leaf point downwards towards the base, the leaf is sometimes styled PEDATE

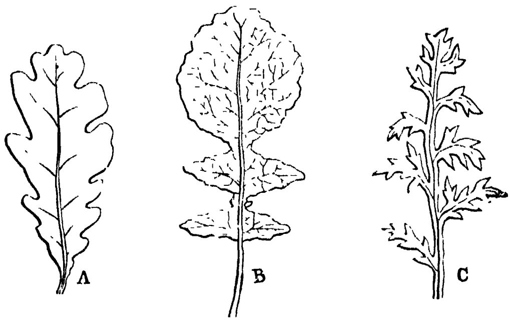


Fig. 37.—A, Pinnifid. B, Pinnipartite and Lyrate. C, Pinnisect.

(see fig. 174). If the blade is cut up into innumerable segments, the leaf is said to be DISSECTED, as in **dhania** or *Coriander*, **juan** or *Ajowan*, &c. When the terminal lobe of a pinnately-lobed leaf is larger than the lateral lobes, the leaf is said to be LYRATE, as in Mustard. Cocoanut-palm, **shial-kanta** (*Argemone mexicana*) (see fig. 63), Radish, **tarmuz** or Water-melon, may be given as examples of pinnately-lobed leaves; and **tal**-palm, Papaw, Castor oil, **sthal-padma** (*Hibiscus mutabilis*), and **kapas** or Cotton (see fig. 167) may be given as examples of palmately-lobed leaves. The leaves which are divided into two lobes, as in *Bauhinia*, are said to be BILOBED.

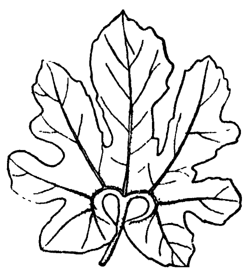


Fig. 38.—Palmipartite Leaf of Chichinga (*Tricosanthes anguina*)

The surface of a leaf may be more or less hairy, or

altogether without hairs. In the latter case the leaf is said to be GLABROUS.

In consistency a leaf may be fleshy and more or less brittle, as **pathar-kucha** and **him-sagar**; or soft and leather-like, as India-rubber, Sapota (*Achras Sapota*), **gab** (*Diospyros Embryopteris*), **pun-nag** (*Calophyllum*), **kadamba** (*Anthocephalus Cadamba*), **nageswar** (*Ochrocarpus longifolius*). In the latter case the leaf is said to be CORIACEOUS. If a leaf is held against the sun, it is found that in some cases, as in Orange, **kamini** (*Murraya exotica*), **kala-jam**, *Hypericum*, the blade is dotted with pellucid glands or dots filled with an essential oil. In fact, these glands are characteristic of the plants belonging to the Orange, *Hypericum*, and **jam** family.

A leaf may have one blade, or more than one; in the former case the leaf is said to be SIMPLE, and in the latter case COMPOUND. In compound leaves the blades are usually small, and are therefore called LEAFLETS. Compound leaves are of two types, namely, PINNATE and PALMATE. In pinnate leaves the petiole is prolonged into an axis known as the RACHIS, on either side of which the leaflets are arranged either alternately or in opposite manner. The rachis or axis may be simple, bearing leaflets on either side; or it may give rise to secondary rachises or axes on either side (instead of leaflets), and these secondary rachises bear leaflets: or the secondary rachises, in their turn may give rise to tertiary rachises or axes (instead of leaflets), and these tertiary rachises bear leaflets in their turn. Accordingly the pinnate leaves are either simply PINNATE (fig. 39), BIPINNATE (see fig. 64), or TRIPINNATE (fig. 40). If the rachis is further branched before bearing leaflets, the leaf is said to be DECOMPOUND. The

rachis may or may not terminate in a leaflet, and accordingly the leaf is said to be IMPARI-PINNATE or PARI-PINNATE. The primary rachis is comparable to the mid-rib, the secondary rachises to the secondary ribs, and the tertiary rachises to the tertiary ribs of a simple pinni-veined leaf. In fact, if the blade of a pinni-veined leaf is cut up into segments between the

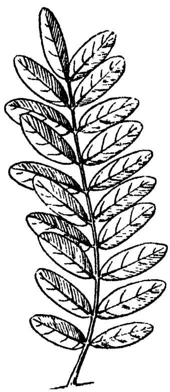


Fig. 39.—Pari-pinnate Leaf of Tentul (*Tamarindus indica*)

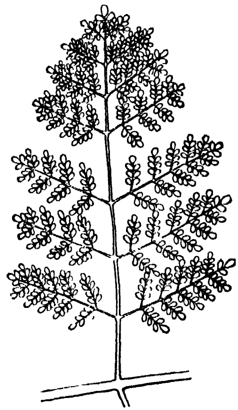


Fig. 40.—Tripinnate Leaf of Sajina (*Moringa pterygosperma*)

secondary and the tertiary ribs, it will give rise to a compound pinnate leaf. Tamarind or **tentul** (see fig. 39), **bak** (*Sesbania grandiflora*) and **kal-kasonda** (*Cassia*) are examples of simple pinnate leaf with no terminal leaflet, that is, pari-pinnate; **krishna-chura** (*Cæsalpinia pulcherrima*), big **krishna-chura** or Gold Mohur (*Poinciana regia*), **babla** (*Acacia*), are examples of bipinnate leaf; **sajina** (*Moringa pterygosperma*) (see fig. 40) and **neem** (*Melia*) are examples of tripinnate leaf. As the presence of three leaflets is very common, such pinnate leaves are termed TER-

NATE (fig. 41), as in **bael** or Wood-apple (*Ægle Marmelos*).

In the palmate leaves the petiole bears at its apex a number of leaflets which look like the fingers of an outstretched hand. In fact, the compound palmate leaf may be looked upon as a simple palmi-veined

Fig. 41.—Ternate Leaf and Axillary Spines of Bael or Wood-apple (*Ægle Marmelos*)

leaf with its blade cut up into as many segments as there are radiating veins by the partial absorption of the soft tissues of the blade between the veins. When the outer leaflets of a palmate leaf point towards the base of the leaf, it is sometimes designated as DIGITATE. As examples of palmate leaves the following may be examined: **amrul-shag** (*Oxalis corniculata*) (see fig. 50), **shimool** or Silk Cotton (fig. 42), white-flowered **hurh-hurhe** (*Gynandropsis*

pentaphylla), yellow-flowered **hurh-hurhe** (*Cleome viscosa*), **tikta-shag** (*Cratæva*), &c. The leaflets of compound leaves are described in the same terms as are used in describing simple leaves. Ternate leaves are either pinnately ternate or palmately ternate, according as the leaflets are petiolate or sessile or subsessile.

The petiole is usually cylindric or semi-cylindric in form, with often a more or less grooved upper surface. In Orange and other plants of this family the petiole is winged and articulated to the blade. In some plants the two margins of the blade run down the two sides of the petiole as two narrow strips. The leaf in such cases is said to be DECURRENT. The petiole is usually attached to the base of the blade; in some leaves, however, as in **pádma** or Lotus, **nil-padma** (*Nymphæa stellata*), **kachu** (*Colocasia*), Garden Nasturtium (*Tropæolum majus*), &c., the petiole is attached to the back of the leaf; such a leaf is said to be PELTATE (fig. 43).

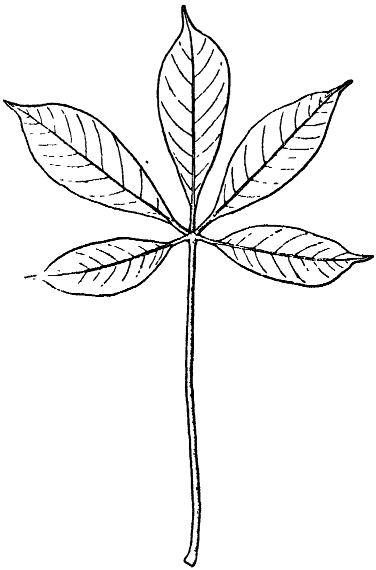


Fig. 42.—Palmate Leaf of Shimool or Silk Cotton (*Bombax malabaricum*)

Often the petiole is accompanied by appendages known as STIPULES. They are usually green, foliaceous, filiform, or scaly structures seen by the side of

a petiole on either side of its insertion on the stem. The stipules are of the following principal types, namely: (1) LATERAL AND FREE, when they are two, one on either side of the petiole and free from it, as in **jaba** or Chinese Rose (see fig. 31), **tentul** or Tamarind, Pea, **krishna-chura**; (2) LATERAL ADNATE (fig. 44), as in Rose, when the two lateral stipules are adherent to the petiole by their inner margins; (3) INTER-PETIOLAR, as in **kadamba, rangan** (*Ixora*) (fig. 45), when the lateral stipules of opposite or whorled leaves unite by their outer margins, so that there is a stipule alternating with the leaves; (4) INTRA-PETIOLAR or axillary when the lateral free stipules of opposite or whorled leaves unite by their inner margins, so that the stipules seem to be axillary, as in **gandharaj** (*Gardenia*); (5) BUD-SCALES, that is, scales enclosing some leaf-buds or flower-buds, as protection against external injury, as in Jack, Banyan, Peepul, and **champa**; (6) LIGULE, that is, a membranous or hairy outgrowth facing the stem at the junction of the blade with the sheath, as in the leaves of Grasses; (7) OCHREA, that is, a membranous tubular sheath which arises from

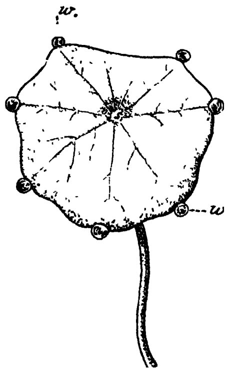


Fig. 43.—Leaf of Garden Nasturtium (*Tropæolum majus*)

w, Water coming out of water-pores.

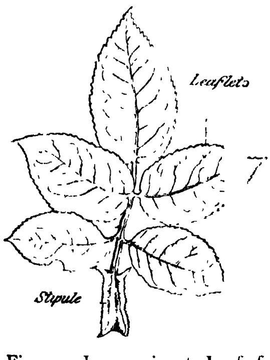


Fig. 44.—Impari-pinnate Leaf of Rose with Adnate Stipules

the axil of a leaf and encloses a portion of the stem above the node, as in **chuka-palong** (*Rumex vesicarius*), **pani-marich** (*Polygonum*) (fig. 230). The ochreas are more or less of an intra-petiolar nature.

Leaves possessed of stipules are said to be STIPULATE, and leaves without stipules, EXSTIPULATE. Stipules are important morphological structures, in so far as their presence or absence and their nature serve as very useful guides in the classification of plants. Thus, for instance, the *Leguminosæ* (Pulse or **dal**-yielding plants), the *Malvaceæ* (**jaba** family of plants), have free lateral stipules; the *Rubiaceæ* (**rangan** and **gandharaj** family of plants) have inter-petiolar stipules; the *Polygonaceæ* (**chuka-palong** family of plants) have ochreaceous stipules; the *Ficus* (Banyan, Peepul, and Fig family of plants) and the *Magnoliaceæ* (**champa** family of plants) have bud-scales; and the Grasses have ligules.

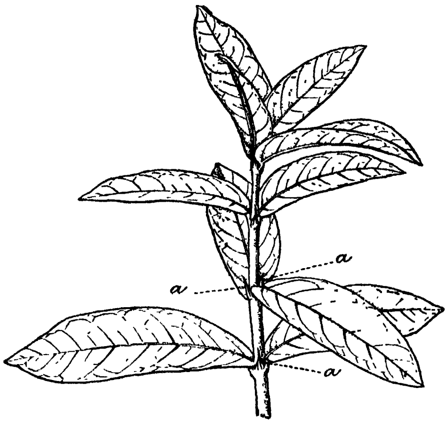


Fig. 45.—Leaves of Rangan (*Ixora coccinea*)

a, a, Inter-petiolar stipules.

The manner in which the young leaves remain folded in the bud, and are arranged with reference to one another, is known as VERNATION or PREFOLIATION. The vernation of leaves is also useful from the point of view of classification. The foldings of the individual leaves are of the following principal

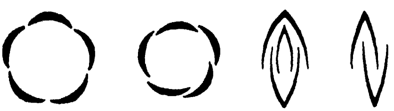
types (fig. 46), namely: (1) CONVOLUTE, as in Plantain, where the leaf-blade is rolled from one margin to the other like a rolled-up map; (2) CONDUPLICATE, as in **kanchan**, where the two halves of the blade are folded with their upper surfaces facing each other like the leaves of a folded book; (3) INVOLUTE, as in **padma**

1 2 3 4 5 6

Fig. 46.—Vernation of Leaves

1, Convolute. 2, Conduplicate. 3, Involute. 4, Revolute. 5, Plicate. 6, Circinate.

or Lotus and **badam** or Country Almond, where the two margins roll inwards towards the mid-rib; (4) REVOLUTE, as in **karabi** (*Nerium odorum*), where the margins roll outwards towards the mid-rib; (5) PLICATE, as in Tal-palm, where the blade is folded upon itself several times; (6) CIRCINATE, as in Ferns and **shushuni-shag** (*Marsilea*), where the leaf is curled up from the apex towards the base, like the tail of a dog; and (7) CRUMPLED, as in Cabbage, where the blade is irregularly folded.



1 2 3 4

Fig. 47. - 1, Valvate. 2, Imbricate. 3, Equitant. 4, Half-equitant.

The way in which the young leaves are arranged with respect to one another in a bud also deserves special notice. The arrangements are of the following principal types (fig. 47), namely: (1) VALVATE, when the leaves are in a whorl with their margins approaching or barely touching one another; (2) IMBRICATE, when the margins overlap one another; (3) EQUITANT, where two

conduplicate leaves wholly or partially enclose each other; and (4) HALF-EQUITANT, where two conduplicate leaves enclose each other by half their blades. These arrangements are seen to best advantage mostly in flower-buds, and will therefore be illustrated with examples in a subsequent chapter.

Leaves are ordinarily flat expanded structures with an upper and an under surface, the former being of a deeper green than the latter. Such leaves are therefore called DORSI-VENTRAL. But leaves like those of Onion are more or less round, vertical, and equally green all round; such leaves are said to be CENTRIC.

In plants like Aloe or **ghrita-kumari**, Agave or **belati-anaras** (see fig. 258), **murga** (*Sansevieria Roxburghiana*), Pineapple or **anaras**, a cluster of leaves seems to arise from the top of the root, as if the plants have no stems. As a matter of fact, in such plants the stem forms as it were a short thick crown of the root, on which the leaves are closely inserted. Such leaves are said to be RADICAL LEAVES as opposed to CAULINE LEAVES, which are attached on the elongated stems or their branches.

CHAPTER VIII

THE LEAF (*Continued*)

We have already learned that leaves originate laterally from the stem in an acropetal order, so that the youngest leaf is nearest the apex of the stem and the oldest leaf nearest the base of the stem. They are usually arranged on the stem either SPIRALLY or in WHORLS. The arrangement is said to be spiral when

the leaves arise singly from each node, as in Mango, so that if a line or thread is carried round the stem, touching the insertion of the leaves in succession, it will describe a spiral. This arrangement is also termed ALTERNATE or scattered (see figs. 30, 31). When there are only two leaves in a node facing each other, they are designated as OPPOSITE, as in Guava. When there are more than two leaves in a node, they are said to be VERTICILLATE. Opposite and verticillately arranged leaves are said to be in whorls. When the successive whorls alternate with one another, so that the leaves of one whorl stand in the intervening spaces between the leaves of the whorl next above it and next below it, they are said to be DECUSSATE, as in **karabi** and **akanda** (figs. 48, 49). PHYLLOTAXY is the name given to the manner in which leaves are arranged on the stem. A careful study of phyllotaxy reveals the important fact that plants adopt every possible means of placing

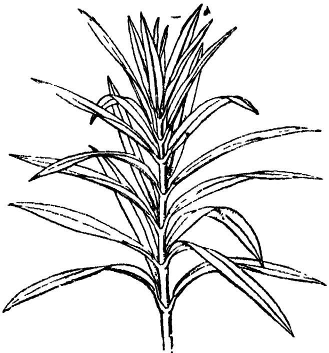


Fig. 48.—Karabi (*Nerium odorum*)

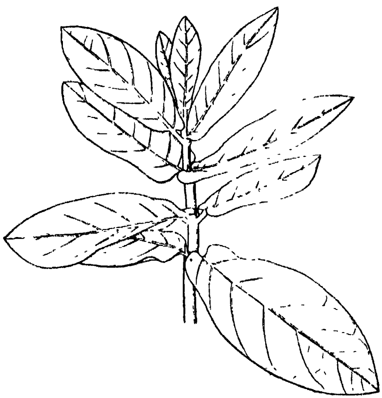


Fig. 49.—Akanda (*Calotropis gigantea*)

their leaves in such a position that they are least interfered with by their neighbours, and their surfaces get the greatest amount of exposure to light. This is evident in plants in which leaves are set apart. In plants in which they are closely set, the arrangement shows a distinct plan, and if the leaves are projected on a level surface they are found to form a singular pattern called LEAF-MOSAIC, in which the leaves,

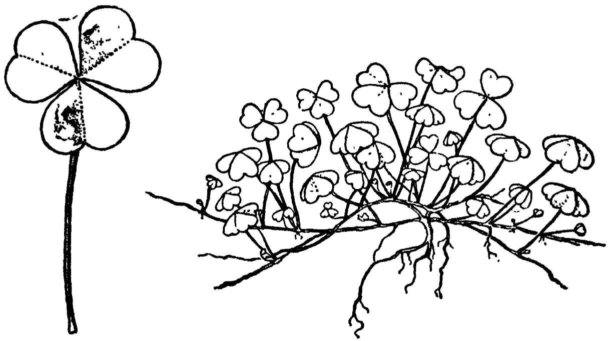


Fig. 50.—Leaf Mosaic—Amrul (*Oxalis corniculata*)

though close-set, fit into the spaces between without overlapping or covering one another. In plants, for example, in which the stem trails or creeps on the ground within a small area, or in plants with radical leaves, the leaves are so crowded together that they may be naturally expected to overlap or even completely cover one another; but in reality they do not do so, but lie as far apart from one another as possible under the circumstances, forming a beautiful leaf-mosaic. For illustration **shushuni-shag** and **amrul-shag** (fig. 50) may be examined. In point of fact, leaves do not brook the least interference with their exposure to light. Look at the gigantic climbers

of tropical forests: they seem to make as it were frantic efforts to reach to the tops of the trees on which they climb for the purpose of exposing their leaf-surfaces freely. The same effort is seen in trees that grow in thick forests. A Mango tree, for example, growing singly and another growing in a Mango tope well illustrate the fact. Common experience also shows that ordinarily no leafy plants grow in the shade, or, even if they do grow, they soon become sickly and pale and ultimately die.

Leaves that are inserted spirally on the stem show a remarkable method in their arrangement. In Grasses, for instance, the leaves are placed on the stem in two vertical lines or ORTHOSTICHIES. The distance between the insertion of two successive leaves measured round the stem is one-half the circumference of a circle. This distance is termed LATERAL DIVERGENCE, and when there are two orthostichies is expressed by the fraction $\frac{1}{2}$; and such an arrangement is described as DISTICHOUS. **Amlaki** (*Phyllanthus*) and **dulal-champa** (*Hedychium coronarium*) are other examples of it. Similarly, the arrangement is TRISTICHOUS when the leaves are arranged in three orthostichies and the lateral divergence is $\frac{1}{3}$; PENTASTICHOUS, with leaves arranged in five orthostichies and the lateral divergence $\frac{2}{5}$; and so on, higher and higher. Thus it is $\frac{3}{8}$ in Papaw, $\frac{5}{13}$ in **amrha** (*Spondias mangifera*), and so on. In all these cases the distance measured spirally round the stem, through the insertion of the successive leaves, from any given leaf as a starting-point to the leaf which is immediately above it in the same orthostichy forms what is known as a CYCLE, the second leaf in the same orthostichy forming the starting-point of the next cycle and being included in the latter. In

the distichous arrangement, one cycle includes two leaves arranged in two orthostichies and one complete turn of the spiral line round the stem: the numerator of the fraction $\frac{1}{2}$, used to designate this phyllotaxy, indicates the number of complete turns of the spiral round the stem to form one cycle, and the denominator the number of leaves or, what is the same, the number of orthostichies in the cycle. In the tristichous phyllotaxy, denoted by fraction $\frac{1}{3}$, one cycle includes three leaves arranged in three orthostichies and one complete turn of the spiral; in the pentastichous phyllotaxy, denoted by the fraction $\frac{2}{5}$, the cycle includes five leaves arranged in five orthostichies and two complete turns of the spiral.

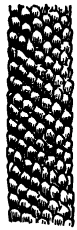
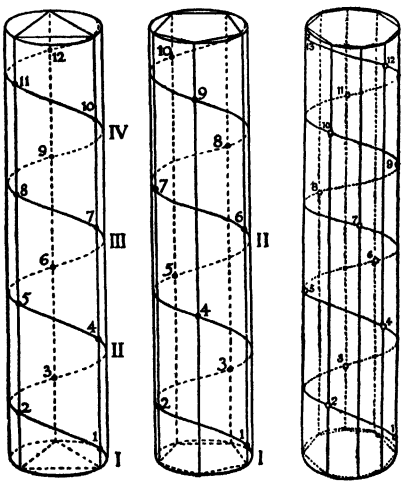


Fig. 51.—Part of Stem of Date Palm —Khejur (*Phœnix sylvestris*)—an example of Parastichy



$\frac{1}{3}$ $\frac{2}{5}$ $\frac{3}{8}$

Fig. 52.—Diagram showing Phyllotaxis of Leaves (longitudinal)

The lateral divergence is often expressed by an angle, and then it is known as ANGULAR DIVERGENCE. Thus the lateral divergence $\frac{1}{2}$ corresponds to angular divergence of $\frac{1}{2}$ of $360^\circ = 180^\circ$; the lateral divergence $\frac{1}{3}$ corresponds to angular divergence of $\frac{1}{3}$ of $360^\circ = 120^\circ$; the lateral divergence $\frac{2}{5}$ corresponds to angular divergence of $\frac{2}{5}$ of $360^\circ = 144^\circ$; and so on. When the spirally arranged leaves are very close set, in

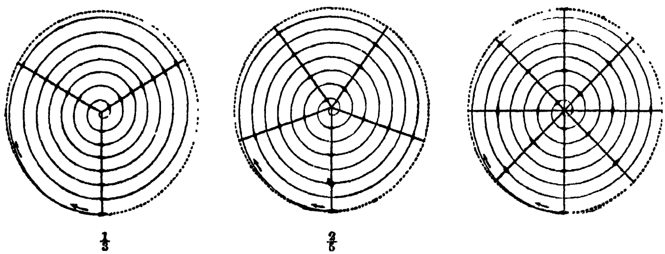


Fig. 53.—Phyllotaxis of Leaves (transverse)

other words, when the divergences are very small, it is often very difficult to make out the orthostichies. In such cases, however, we find well-marked lateral or diagonal stichies known as PARA-STICHIES. These para-stichies can easily be made out on the stems of Date-palms (fig. 51), tal-palms, &c., because in them the leaf-bases or leaf-cicatrices are left behind when the leaves fall off. The above diagrams are given to illustrate the longitudinal (fig. 52) and transverse projections (fig. 53) of $\frac{1}{3}$, $\frac{2}{5}$, and $\frac{3}{8}$ phyllotaxy.

CHAPTER IX

BRANCH SYSTEM

Stems of most plants that we see around us are branched, as Banyan, Mango. Some stems, however, are not branched, as Cocoanut-palm, Date-palm, &c. We have learned that the stem grows in length by the growth of the terminal bud, and branches by the growth of the lateral or axillary buds, and that it remains unbranched owing to the non-development of the axillary buds. That this is so is proved by the fact that an unbranched stem like that of the Date-palm is occasionally seen with two or more branches near its apex, which are no doubt due to abnormal growth of axillary buds, which ordinarily remain dormant. Such abnormal growths, in fact abnormal growths of any kind, are known as monstrous growths or MONSTROSITIES.

In the kind of branching mentioned above, the plumule or primary bud of the embryo develops into the primary axis or stem, which continues to grow in length by the growth of the bud at its apex, that is, the terminal bud. The axillary buds on the sides of the primary stem similarly develop into secondary axes or branches, each of which grows in length by the development of its own terminal bud. The secondary branches may again branch similarly into tertiary branches, and so on. Such a system of branching is known as RACEMOSE. It is also called MONOPODIAL, because the main axis is developed from one single bud or foot (podium), on which stand the lateral axes or branches. This is the most common form of branching in Phanerogams. In trees, during subsequent growth, the branches often grow so enormously

that the distinction between the primary axis and its branches is wholly lost, excepting so far that their trunks still represent the basal portion of the primary axis. Racemose branching is also the rule in the root and leaves of Phanerogams.

In some cases, as in many Cryptogams, the terminal bud of the stem divides into two branches, each of which grows equally, and the terminal bud of each of the two branches again divides in its turn into two branches, and so on. Such a system of branching is known as DICHOTOMOUS (see fig. 54). Similarly, though rarely, the branching may be TRICHOTOMOUS.

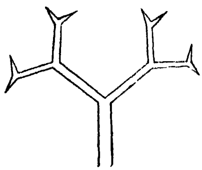


Fig. 54.—Diagram of True Dichotomy

In some cases the terminal bud of an axis or stem soon ceases to grow in length, and the lateral buds immediately below it develop into strong branches or secondary axes. The terminal buds of these branches or secondary axes in their turn soon cease to grow in length, and lateral buds immediately below them develop into branches or tertiary axes, and so on. Such a system of branching is described as CYMOSE.

In cymose branching where two lateral buds only are developed, the branching takes the external form of dichotomy, but is not true dichotomy, inasmuch as the branches do not arise from the bipartition of the terminal buds. Such apparently dichotomous branching is therefore known as false dichotomy or DICHASIUM (fig. 55, A). Similarly, there may be false trichotomy or TRICHASIUM. **Katchampa** (*Plumeria acutifolia*), **karancha** (*Carissa Carandas*), and **krishnakali** or Marvel of Peru are good examples of false dichotomy; and **karabi** (*Nerium odorum*) is a good

example of false trichotomy. False dichotomy or trichotomy is very rare in the stems, roots, or leaves of plants, but very common in inflorescence or branch-system bearing flowers, which will be described later on.

In cymose branching, if one only of the successive lateral buds develops into a branch, and these developing buds are all on the same side (right or left) of the terminal buds, the branching is said to be a

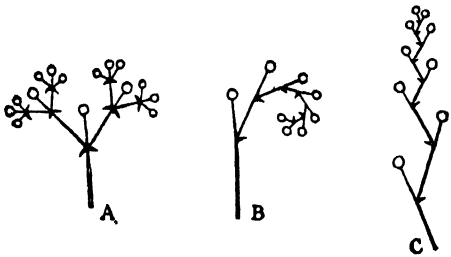


Fig. 55.—Cymose Branching

A, False dichotomy or dichasium. B, Helicoid cyme. C, Scorpioid cyme.

HELICOID cyme (fig. 56, B). If, on the other hand, the developing lateral buds lie alternately right and left of the terminal buds, the branching is said to be a SCORPIOID cyme (fig. 55, C). In both the kinds of cymose branching described above the apparent axis is not a monopodium, as in racemose branching, but a SYMPODIUM (joint-axes), formed by the successive portions of the primary, secondary, tertiary, &c., axes. **Harhjorha** (*Vitis quadrangularis*) and the Vines generally are good examples of plants having a sympodial axis or shoot. In dichotomous branching also, for similar reasons, the pseudo-axis or sympodium may be helicoid or scorpioid.

CHAPTER X

METAMORPHOSIS IN PLANTS—ARMATURE IN PLANTS — INSECTIVOROUS PLANTS — HOMOLOGY AND ANALOGY—TRICHOMES.

It has already been mentioned that when a stem is so modified in shape and form as to resemble a leaf it is called a CLADODE, as in **phani-monsha** and

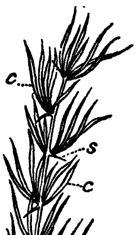
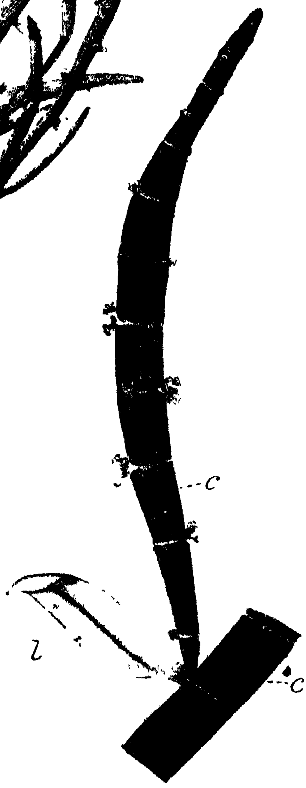


Fig. 56.—Satamoolee (*Asparagus racemosus*)
c, Cladode.
s, Spine.

Fig. 57.—Leaves of Acacia
a, *b*, Phyllodes.

Coccoloba Platyclada (see fig. 26 and Plate I). The axillary tufts of green needle-like structures in **satamoolee** or *Asparagus* are modified branches or cladodes (fig. 56). In the Australian genus of **babla** or *Acacia*, the leaflets of the compound pinnate leaf fall off soon after their appearance, and the petiole, flat-

(about , natural size)



(enlarged)

Coccoloba platyclada
l, leaf; *c*, cladode

tening out, takes the form and colour of a leaf, and performs its functions. Such a leaf-like modification of the petiole is termed a PHYLLODE (fig. 57).

TENDRIL is the name given to thread-like modifications of buds, leaves or parts of leaves, and other morphological units by the help of which plants climb upon other plants or supports. For example, the tendrils of **harhjorha** (*Vitis quadrangularis*), **goale-lata**

Fig. 58.—Matar (*Pisum sativum*) *t*, Tendril. *f*, Flower. *st*, Foliaceous stipule.

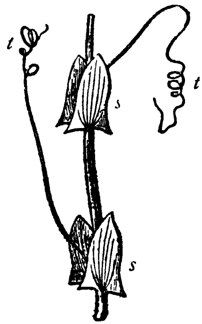


Fig. 59.—Tendrils (*t*) and Leaf-like Stipules (*s*) of *Lathyrus Aphaca*

(*Vitis pedata*) (see fig. 174), and other Vines, which are leaf-opposed, are modified terminal leaf-buds; those of **jhumka-lata** or the Passion flower (see fig. 193) are modified axillary leaf-buds; those of **matar** or Pea (fig. 58), **masur** or Lentil, **mash-kalai** and **moog** (*Phaseolus*), **chhagal-bati** (*Naravelia zeylanica*), and of many *Bignonias* are modified leaflets of compound leaves; those of **ulat-chandal** (*Gloriosa superba*) (see fig. 249) are modified leaf-apices; those of **jangli-**

matar (*Lathyrus Aphaca*) are whole leaves modified (fig. 59); those of **kumarika** (*Smilax macrophylla*)

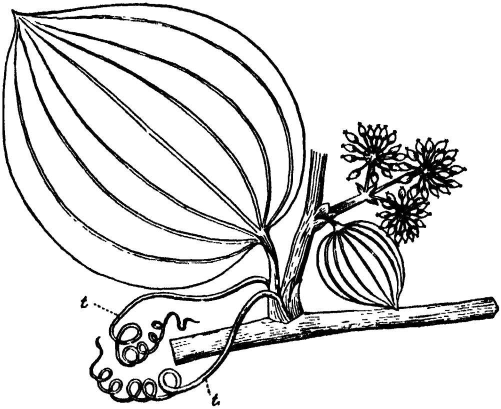


Fig. 60. Smilax macrophylla (kumarika)
t, *t*, Stipule-tendrils.

(fig. 60) are modified stipules; those of *Antigonon leptopus* (a common garden climber with racemes of pale-red or white flowers) and of *Cardiospermum Halicacabum* (fig. 61) (a common climbing weed) are modified floral axes; and those of **isher-mul** (*Aristolochia indica*), *Clematis* (see fig. 144), and Garden Nasturtium (*Tropæolum majus*, a common garden annual), are spirally twisted petioles.

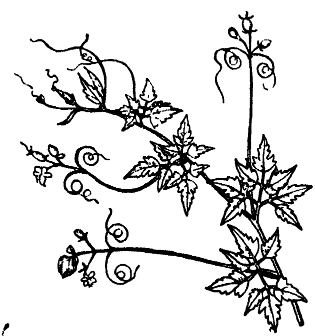


Fig. 61.—Shib-jhul (*Cardiospermum Halicacabum*)

Spines or thorns are sharp-pointed structures commonly met with in plants. They are metamorphosed

buds, leaves, stipules, or other morphological units. They are connected with the deeper parts of the members of the plant body from which they spring, and hence they are difficult to remove without injury to the plant. In Wood-apple or **bael** (see fig. 41), **kath-bael** (*Feronia*), **bengchi** or **bonch** (*Flacourtia sepiaria*), **nebu** (*Citrus*), and in **bagan-bilas** (*Bougainvillea*) the spines are modified leaf-buds. In **kantali-champa** the recurved spines are modified peduncles or flower-buds, and the straight spines are terminal buds of stunted branches. In Rangoon Creeper (*Quisqualis malabarica*, a common garden climber) the leaves when mature shed their blades, leaving the petioles as spines. In **kul, teshira-monsha, monsha,** and **babla** the spines are modified stipules. In **nag-phani** (see fig. 26) the spines surrounded by short bristles are probably modified leaves.

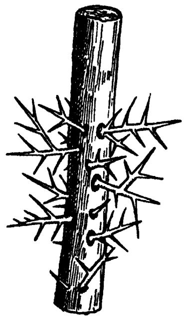


Fig. 62.—Pani-ala or Pani-amrha (*Flacourtia Cataphracta*)

The stems of **pani-ala** or **pani-amrha** (*Flacourtia Cataphracta*) (fig. 62) are beset with big compound spines in their lower portion, the upper portion being free from them. Many plants are similarly provided with spines over the stem and leaves. These are outgrowths from the subepidermal tissue, and are not referable to any particular member of the plant body, such as buds, leaves, stipules. Besides the spines, many plants, e.g. the Rose, are armed with PRICKLES, which are epidermal growths, and can therefore be easily separated without injury to the parts on which they grow; or armed with GLANDULAR hairs, which are also epidermal growths, as in **lal-bharenda** or **sayambara**

(*Jatropha gossypifolia*), **bichuti** (*Tragia involucrata*), the pods of **alkushi** (*Mucuna pruriens*) (see fig. 179), and the involucre of *Siegesbeckia* (see fig. 201).

Spines, prickles, and glandular hairs are the armature of plants, by which they defend themselves against the attack of animals. Sir George Watt, writing on armature of plants, says: "The plant manifests distinct efforts to defend itself from the attack of animals. Every part of **shial-kanta** (*Argemone mexicana*) (fig. 63) is one mass of pointed bodies which protect it most successfully. The **bael**, **ankar-kanta** (*Alangium Lamarckii*), **karancha**, and **babla** are very efficiently armed. In all these cases you observe the spines or sharp-pointed bodies are perfectly straight and nearly horizontal, because for trees they are more useful in that attitude; they are also not developed, you may observe, upon the higher parts of the trees. In erect shrubs, such as **bengchi**, **moyna** (*Vangueria spinosa*), and **kanta-nate** (*Amarantus spinosus*), they are also straight but ascending as if to meet the nose of the grazing cow. The **babla**, when young, has ascending spines, but as the plant grows to a small tree they become straight and horizontal. It is interesting to observe that in climbing plants the spines and prickles are rarely straight, but are bent or curved downwards. In such plants it is evident that they serve a double purpose: they defend the plant, but at the same time assist in elevating it by hooking on to objects that are near. The **bagan-bilas**,

Fig. 63.—Shial-kanta (*Argemone mexicana*)

kumarika, golap or Rose, and **nata** or Fever-nut (*Cæsalpinia Bonducella*) are all good examples of this. In the last (**nata**) the under-surfaces of the leaf-stalk are covered with hooked prickles, and when once laid upon an object firmly lay hold of it; hence this plant often covers completely the lower vegetation, effectually preventing anything from passing through its prickly leaves and branches. The formidably-branched spines of **pani-ala** (see fig. 62) being only developed on the lower part of the stem, suggest the idea of their being the product of a distinct knowledge on the part of the plant that a tree requires spines or armour upon its lower parts only."

While speaking of the armature of plants, that is, contrivances by which plants defend themselves from the attack of animals, it will not be out of place to mention here that, besides spines, prickles, and glandular hairs, many plants are furnished with an acrid milky or watery juice, many with a repulsive smell, and many with a bitter taste, which serve as effectual means of self-defence. For example, **rang-chita** (*Pedilanthus*), **bag-bharenda** (*Jatropha*), **akanda**, and **chhatim** (*Alstonia*) are provided with an abundance of acrid milky or watery juice which is repulsive to cattle. For this reason they are mostly used as hedge-plants. Similarly, **gandha-bhadali** or **gandhal** (*Pæderia fœtida*), **dhania** (*Coriandrum*), **sulpa-shag** (*Peucedanum Sowa*), **madhu-phal** (*Salacia prinoides*), &c., turn away the grazing cattle by their odour, and are therefore often cultivated among field-crops as means of protecting the latter. The **neem, patal**, &c., do the same thing by their bitter taste. Many unarmed plants grow under armed plants, and thus protect themselves with the help of their armed neighbours.

Some American species of *Acacia* (**babla**) (fig. 64)

protect themselves from the attack of leaf-cutting insects with the help of a species of warlike ant which they shelter in their hollow stipulary thorns, and feed with what have been called "Belt's corpuscles", which are waxy food-bodies attached to the tips of the leaflets. A species of *Cecropia* (also American plants), belonging to the Natural Order *Urticaceæ*, similarly harbour a species of ant in their hollow internodes, and feed them with what have been called "Muller's

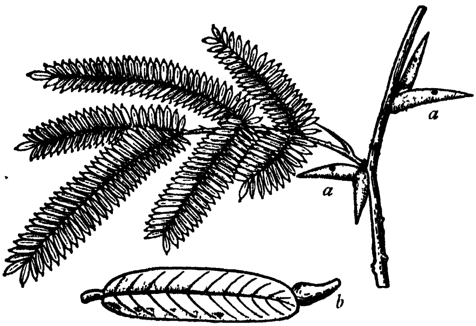


Fig. 64.—Acacia sphaerocephala (a kind of *babla*) (after Strasburger)

a, Punctured spines. *b*, Belt's corpuscles.

bodies" secreted on the leaf-bases. This housing and feeding of warlike ants is an adaptation to environment enabling the plants to ward off the attack of leaf-cutting insects. According to the authors of this theory, the leaf-cutting insects cut the leaves of *Cecropia* and carry them to their nests, where the leaves are kneaded up into a kind of bread for feeding the "Fungus-(chhata)-garden", in which they grow a kind of Fungus for their own food. Plants with such adaptations to withstand attacks from injurious insects are called MYRMECOPHILOUS or ant-loving. The housing of ants in the hollow stem or thorn, and

the existence of "Belt's corpuscles" and "Muller's bodies" are well-known facts, but whether they are a

Fig. 65.—Pitcher Plant (*Nepenthes Rafflesiana*)

protective arrangement has been disputed by some observers.

PITCHERS (fig. 65) are jug-shaped modifications of leaves. The pitchers of the Pitcher-plant of the Indian Archipelago are well-known examples. The

common **jhangi** (*Utricularia*) (fig. 66) of our tanks bears small bladders or pitchers among the capillary segments of their leaves (fig. 67). The bladders have each a small valve (*a*) which opens only inwards. Small insects that can hardly be seen by the naked eye pass in through the opening and are caught as in a trap set for them. For, as they enter, the valve closes

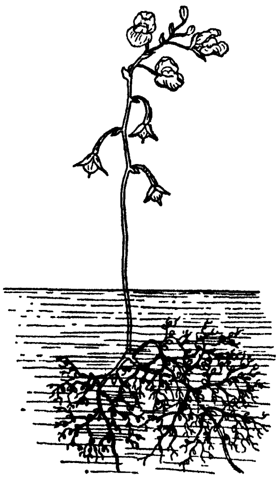


Fig. 66.—Common Jhangi (*Utricularia stellaris*)

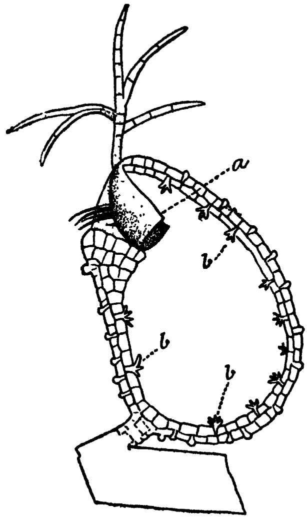
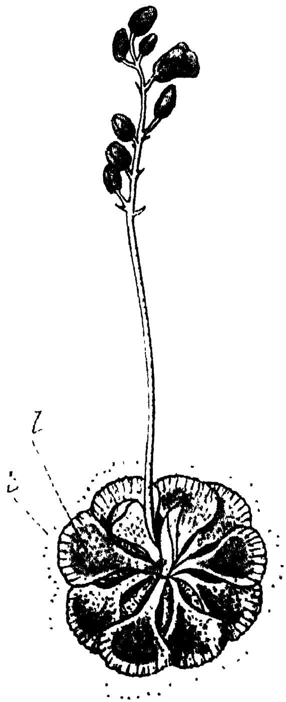


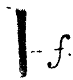
Fig. 67.—Section of Bladder of Utricularia—enlarged (after Strasburger)

a, Valve. *b*, Gland.

behind them, and within there is a fluid which soon kills and decomposes them, and they are absorbed or eaten, being reduced to a liquid capable of absorption by osmose. The digestive fluid within the bladders is secreted by the glands (*b*) situated on the inner wall of the bladders. The pitchers of the Pitcher-plant mentioned above are similarly traps for capturing insects on which the plants feed. Such plants are therefore known as INSECTIVOROUS plants.



A



There is another Bengal plant which, though it develops no pitchers, is highly insectivorous. This is a small herb (*Drosera Burmanni*) (Plate II) found in the fields during the cold season in Burdwan and Chota Nagpur districts. It may be seen in large numbers in the waste lands bordering the road from Giridih to the Pareshnath Hills. They are of a reddish colour, and the leaves are covered with glandular hairs called TENTACLES. The rosette of radical leaves looks from a distance like a circular red spot caused by the spittle of a man when chewing betel (**pan**); hence the plant in some districts goes by the name of **paner-pik.** "Each hair secretes a drop of fluid which shines so bright in the sun that insects are induced to alight upon it in the hope of getting a sip of water. The fluid, however, is so sticky that the unfortunate insects cannot get away from it. Every effort they make puts the hope of escape farther and farther away; for gradually the hairs collect, bend over, and take a firm hold of them. The insects caught by this trap soon lose their strength and die, and are decomposed and absorbed."—*Sir George Watt.*

Drosera peltata, var. *lunata* (Plate II), another insectivorous plant, though not of Bengal proper, is common in the Khasi Hills (Shillong) of Assam. It is a small annual of about 6 to 8 inches in height, with a rosette of radical leaves and also alternate cauline leaves, or only the latter, and a thin erect stem which sometimes gives off one or two branches towards the apex. Whether radical or cauline, the leaves, as the name signifies, are peltate, crescent-shaped, about one-fourth of an inch in length and breadth, petiolate; and the lamina is beset with glandular tentacles which are long on the margin, especially at the horns of the crescent, and gradually become shorter and shorter

till they are sessile in the middle of the blade. The leaves are green, the tentacles light-red, and the glands at their head dark-red. The terminal flowers open in the morning with a conspicuous milk-white spreading corolla, and are thus very attractive as they render the otherwise inconspicuous plants highly conspicuous. The glands secrete a viscid transparent liquid which sparkles in the morning sun like dew-drops. The manner in which the leaves catch flies is very similar to that of *Drosera Burmanni.* Often whole flies or remnants of them are seen lying on the upper surface. The mode of digestion is also similar.

Venus's Fly-trap (*Dionæa muscipula*) (see fig. 184), the well-known insectivorous plant of North America, has a representative in Bengal in the floating weed known by the name of Malacca-jhangi (*Aldrovanda vesiculosa*). It lives, like the *Utricularia*, floating in water, and is devoid of roots. The stem is thin and articulated, and the leaves are in whorls. Each leaf consists of a petiole flattened towards the top, and the lamina is simple, roundish, but notched at the apex, and terminating in bristles. The two halves of the lamina are inclined inwards, forming an angle at the mid-rib, and the two margins are involute and covered with conical points. On the surface of the blade, especially along the mid-rib, there are a number of pointed hairs, not six hairs as in Venus's Fly-trap. Moreover, the blade is studded all over with sessile glands. If minute animal larvæ, &c., that swim about in water happen to touch the hairs on the upper surface of the blade, the two halves of the blade immediately close, forming a sort of temporary stomach, as it were, and any attempt on the part of the insects to escape from the trap is effectually prevented by the involute margins, which are

provided with sharp fine teeth. How they are dissolved and digested has not yet been fully investigated, but the probability is that the glands secrete a digestive juice, as in *Drosera*. Bits of the plant are seen floating in the salt-pans round about Calcutta (see figs. 68, 69).

The **lal-bharenda** (*Jatropha gossypifolia*) is also

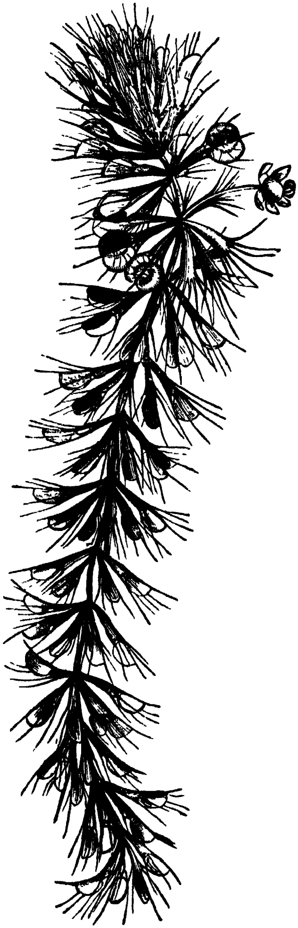


Fig. 68. — Malacca Jhangi (*Aldrovanda vesiculosa*)

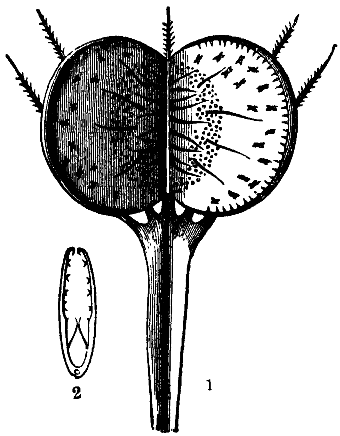


Fig. 69. - Capturing Apparatus of Leaves of Aldrovanda

1, Expanded leaf. 2, Section of a closed leaf.

seen to have insects on the glandular hairs of its leaves and stems, and it is highly probable that the plant derives its nourishment from them. We know

too that the leaves of the Tobacco plant are very sticky, and are also seen to be covered with insects—some dead and others struggling to escape—and the probability is that it is also partly insectivorous. It is worth adding that well-known insectivorous plants like *Drosera* never have large roots, a fact which confirms the view that their leaves take part in the absorption of food.

The Tobacco and **lal-bharenda** plants referred to above are perhaps Indian representatives of the Fly-catcher of Europe and Africa with its rosettes of long and narrow radical leaves full of short-stalked glands, which remind one of the long-stalked glands of *Drosera*. These glands secrete a liquid which glistens in the sunshine like dew-drops.

That cladodes, phyllodia, tendrils, spines or thorns, and pitchers or bladders are metamorphosed buds, leaves, stipules, or other morphological units is made out by their HOMOLOGY; that is to say, their resemblances to buds, leaves, &c., in origin, development, and position. For example, as described above, the thorns of **kul**, **teshira-monsha**, occupy the position of stipules, and are therefore homologous with them; the tendrils of Pea homologous with the upper leaflets of the compound pinnate leaf; the tendrils of *Naravelia zeylanica* homologous with the terminal leaflet of its ternate leaves. Similarly, we shall soon have to discuss the point that flowers are homologous with leaf-buds, and that floral leaves and foliage leaves are also homologous structures. A study of homology, therefore, is invaluable in the elucidation of plant morphology. Organs which resemble one another in their origin, development, position, and place in life-history, so that we regard them as morphologically the same organ, however different they may appear

to be in their form, are said to be HOMOLOGOUS with one another. On the other hand, organs which are morphologically different, but are adapted to the same physiological function, are said to be ANALOGOUS. Thus the tubers of a potato are homologous with a branch but analogous with a fleshy root like that of a **ranga-aloo, shank-aloo**, Radish, &c., being reservoirs of food-materials. Similarly, the cladode of *Coccoloba platyclada* is homologous with a stem but analogous with a leaf, and the leaf-like thin green cylindric grooved and jointed structures of **jhau** or Beefwood (*Casuarina*) which have short sheaths of connate scales at intervals are analogous with leaves but homologous with branches.

TRICHOMES is the name given to all epidermal growths. Thus the HAIRS met with in young growing roots, stems, leaves, &c.; the bristles or stinging hairs, as in **jal-bichuti, lal-bichuti**, and in pods of **alkushi**; glandular hairs, as in **lal-bharenda** and *Drosera*; scales (ramenta), as in Ferns; and prickles, as in Rose, are all trichomes. Hairs vary much in their form, length, number, fineness, and setting. Thus a surface covered with soft scattered hairs is said to be PILOSE; with long, scattered, stiff hairs, HIRSUTE; with short, stiff hairs, HISPID; with close-set, soft, short hairs, PUBESCENT; and with long, soft, interwoven hairs, TOMENTOSE.

CHAPTER XI

INFLORESCENCE

We have learnt that buds are either terminal or axillary; and buds, we have seen, develop leaves, which may be foliage or floral leaves. In the first case the buds are known as foliage or LEAF-BUDS, and in the second case floral or FLOWER-BUDS.

A flower-bud on developing may give rise to a solitary flower or to an axis or a branch-system of axes bearing many flowers. In the latter case the branch-system is known as INFLORESCENCE. The solitary flower or inflorescence, as the case may be, is either terminal or axillary according as the bud from which it is developed is terminal or axillary. In a solitary flower the stalk on which the flower is borne is termed the PEDUNCLE. In an inflorescence the main axis may remain unbranched and bear flowers, or it may give rise to secondary or tertiary axes, the latter bearing flowers. The portion of the axis which bears flowers or branches is known as the RACHIS, primary, secondary, or tertiary as the case may be; and the portion that does not bear flowers or branches is known as the peduncle, as in solitary flowers. The flowers of an inflorescence may be sessile or borne upon stalks or PEDICELS. Flowers and inflorescences usually originate from the axils of small green leaves which are known as BRACTS. If there are other bracts than these, they are known as BRACTEOLES. Bracts are usually diminutive green leaves, but occasionally they are coloured and conspicuous, as in **bagan-bilas, rang-chita, lạl-pata** (*Euphorbia pulcherrima*).

Inflorescences are of various kinds, and may be

grouped into two heads, namely: (1) RACEMOSE or INDEFINITE, and (2) CYMOSE or DEFINITE.

Racemose inflorescences, as the name signifies, are essentially monopodial. The following are the principal forms (fig. 70): (1) RACEME (*r*), an inflorescence in which the axis or rachis goes on growing indefinitely and producing equally pedicillate flowers in an acropetal order; (2) SPIKE (*s*), a

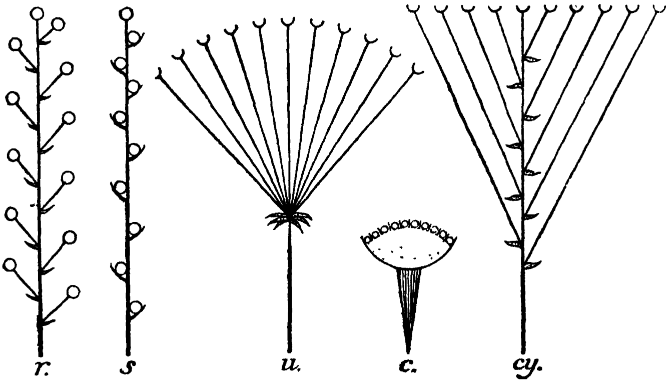


Fig 70.—Diagrams of Various Types of Racemose Inflorescence

r, Raceme. *s*, Spike. *u*, Umbel, *c*, Capitulum. *cy*, Corymb.

raceme with sessile flowers; (3) SPADIX, a spike with a thick rachis enclosed within a big membranous or woody bract or bracts known as SPATHE (fig. 71); (4) CORYMB (*cy*), a raceme with its flowers brought to a nearly level top by the unequal growth of the pedicels; (5) UMBEL (*u*), a raceme with its rachis suppressed so that the equally pedicillate flowers all spring from the apex of the peduncle; and (6) CAPITULUM (*c*), a spike with its rachis widened out radially in the form of a head or receptacle and the sessile flowers inserted upon it. In raceme and spike the

flowers open successively from the bottom towards the top, whereas in corymb, umbel, and capitulum they open successively from the circumference towards the centre, or centripetally. In either case, however, the order of opening of flowers is acropetalous. In an umbel or capitulum the apex of the peduncle from which the pedicels or the widened head arise is usually clothed with a whorl of bracts known as an INVOLUCRE. Racemes, spikes, spadices, and umbels may be simple or compound, according as the floral axis is unbranched or branched. Compound racemes are very common, hence they are designated by the special name of PANICLE. In capitulum the flowers are usually closely crowded together and very small, and are therefore known as FLORETS or little flowers. All the florets may be similar in shape, or, as is more common, the florets of the circumference known as RAY-FLORETS differ in shape from the florets of the centre known as DISK-FLORETS, the ray-florets being usually ligulate, and the disk-florets tubular. The head of a capitulum is often provided with small scaly or slightly coloured bracts known as PALEA, which embrace the florets. When the palea are absent the

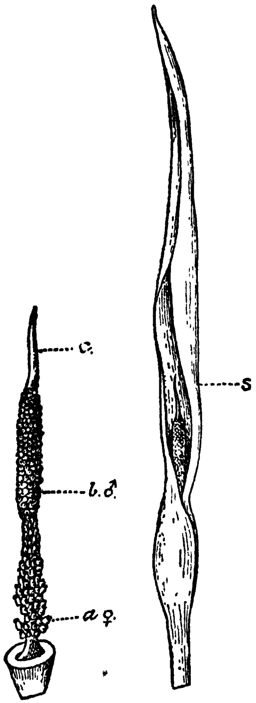


Fig. 71.—Kachu (*Colocasia antiquorum*)

a, Female flowers ♀. *b*, Male flowers ♂. *c*, Appendix. *s*, Spathe.

capitulum is said to be naked. Again, the head is usually flat, slightly convex or concave, but occasionally it is excavated, and takes the form of a rounded jug, with a small opening at its apex, as in **dumur** (*Ficus hispida*) (fig. 72), **aswathwa** or Peepul, and **bot** or Banyan. When a large number of small flowers is collected together on a point without a prominent and wide head, the flower-head is said to be CAPITATE, as in **babla** or *Acacia* and **kadamba** (*Anthocephalus Cadamba*). When a spike is pendulous and (usually) consists of unisexual flowers, and falls off as a whole when matured, it is said to be a CATKIN. **Sharisha** or mustard, **krishna-chura, rerhi** or Castor oil, **lichoo** or Litchi, **neem** (*Melia*), and **sondal** or Indian Laburnum (*Cassia Fistula*) are examples of raceme and panicle; **kanta-nate, rajani-gandha** (*Polyanthes tuberosa*, Willd.), **palang-shag** or Spinach (*Spinacia oleracea*), are examples of spike; **pituli** (*Trewia nudiflora*), **toont** or Mulberry, and **pan** or Betel Vine (see figs. 236 and 245) are examples of catkin; **kachu** (see fig. 71), **khejur**, Cocoa-nut, and Plantain are examples of simple and compound spadix; **rangan** (*Ixora parvifolia*) and **kukur-churha** (*Pavetta indica*) are examples of corymb; **dhania** and **mauri** are examples of umbel; **surya-mukhi** or Sunflower, **gendha, kuk-shima** or **kukur-songa** (*Vernonia cinerea*), are examples of capitulum.

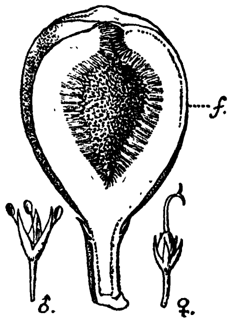


Fig. 72.—Dumur (*Ficus hispida*)

f, Longitudinal section.
♀, Female flower.
♂, Male flower.

In cymose or definite inflorescence the main axis

does not elongate indefinitely as in the racemose type, but terminates in or is defined by a flower, and produces below it one or more secondary axes, each of which in its turn terminates in a flower. The principal forms of it, as indicated in Chapter IX, are: (1) FALSE DICHOTOMY, or DICHASIUM, or BIPAROUS CYME; (2) HELICOID, UNIPAROUS, or ONE-SIDED CYME; (3) SCORPIOID or ALTERNATE-SIDED CYME. The cymes may take the apparent forms of racemose inflorescences, when they are distinguished as cymose corymb, cymose umbel, cymose panicle, &c. In many cymose inflorescences the flowers are crowded together in clusters, the central flowers of which open first and the other flowers open in succession from the centre towards the circumference or CENTRIFUGALLY. In the cymose type the branching is essentially sympodial.

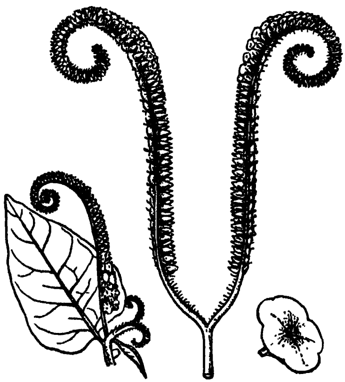


Fig. 73.—Hati-soonrh (*Heliotropium indicum*)

The **lal-bharenda**, Coral plant (*Jatropha multifida*), **ghentu** (*Clerodendron*), and Pink (*Dianthus chinensis*, L.) are examples of dichasium; **hati-soonrh** (*Heliotropium indicum*) (fig. 73) and *Hyoscyamus niger* are examples of scorpioid cyme; most plants of the *Solanum* or Potato family are examples of helicoid cyme. In **rang-chita** (see fig. 114) and **teshira-monsha** (see fig. 232) there is a cymose head of flowers (CYATHIUM) embraced within an involucre of one or more calyx-

like bracts; this involucre is scarlet-red and boot-shaped in the former, and cup-like and glandular in the latter. The showy garden plant **lal-pata** (*Euphorbia pulcherrima*), with cymose heads of flowers, has at the base of each head of flowers a number of large scarlet-red bracts. The **bagan-bilas** has a cymose group of three flowers inserted on the mid-rib of a large pale-purple bract. Dichotomous cyme or dichasium is very common, but TRICHOTOMOUS CYMES are sometimes met with, as in **sheuli** (*Nyctanthes Arbor-tristis*) and *Jasminum*.

In plants with suppressed stem, or with underground stem, the flowering axis seems to arise apparently from the root, and bears either a single flower or a number of flowers. Such a flowering axis is called a SCAPE, and plants producing SCAPES are said to be SCAPIGEROUS or scape-bearing. A scape may be single-flowered, as in **padma** or Lotus, or racemose, as in **murga** (see fig. 258), or spiked, as in **rajani-gandha**, or umbellate, as in Onion. Many aquatic and marshy Monocotyledons are scapigerous herbs.

CHAPTER XII

THE FLOWER—PART I: MODIFIED SHOOT

A flower is a bud or shoot metamorphosed for the purpose of reproduction. The flower, however, looks so very different from a shoot that it is difficult to realize their identity at first sight. But that identity is clearly established by the following considerations. We have learned that a shoot consists of an axis divided into internodes, with leaves inserted on each

of its nodes either spirally or in whorls. If we suppose the internodes of such a shoot to be suppressed or undeveloped, the axis then will be reduced to a short head, and the leaves brought close together and arranged either spirally or in whorls on that head. If we now examine a flower like that of **champa** (fig. 74) (see also fig. 148), we find that it consists of a short axis on which are inserted close together, first, from nine to twenty yellowish leaves, secondly, numerous small linear bodies above them, and, lastly, numerous rounded hooked bodies at the top. Similarly, if we examine a flower like that of **kantali-champa** (*Artabotrys odoratissima*), we find that it consists of a short axis or head on which are inserted, first, a whorl of three green leaves at the bottom, secondly, two whorls above the first, each of which consists of three yellow leaves, thirdly, numerous short oblong linear bodies above them, and, lastly, numerous round bodies densely-crowded at the top. The flowers of *Magnolia grandiflora* and **dulee-champa** (*Magnolia pterocarpa*) disclose on examination a similar state of things. Now the structure of all these flowers agrees closely with that of the shoot which has been supposed to have its axis suppressed or undeveloped. Thus the short axis of the flower represents the short axis of the supposed suppressed stem, and the yellow or green leaves, the linear or oblong bodies, and the rounded bodies of the flower all represent the green leaves of the suppressed axis. That the lower leaves of the flowers are modified

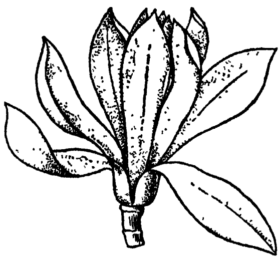


Fig. 74.—Champa (*Michelia Champaca*)

foliage leaves is not difficult to infer from their form, and often from their colour, although the same thing cannot be said of their upper leaves. We shall, however, soon see that the upper leaves, however much they may seem to differ from foliage leaves, are also really such.

A COMPLETE flower usually consists of a short axis, known as the THALAMUS, on which are inserted four whorls of leaves in succession: the outer or lowermost whorl is known as the CALYX and each segment of it a SEPAL; the next whorl is known as the COROLLA and each segment of it a PETAL; the next whorl is known as the ANDRŒCIUM and each segment of it a STAMEN; and the last whorl is known as the GYNŒCIUM or PISTIL and each segment of it a CARPEL. Of the flowers above, the last three have each a calyx of three green sepals, a corolla of six yellow or white petals arranged in two whorls of three each, an andrœcium of numerous stamens, and a gynœcium of numerous carpels; and the first agrees closely with them in its andrœcium and gynœcium, but differs in having at its base several whorls of leaves of the same colour and form, which therefore cannot be distinguished as calyx and corolla, but are collectively called by the name of PERIANTH. The following easily available flowers may be examined in the absence of those mentioned above, namely, **shial-kanta**, **amrul-shag**, **dhutura**, **afing** or **posto** or Poppy, **nebu** or Orange.

In flowers the internodes are, as a rule, suppressed, but in white-flowered **hurh-hurhe** (*Gynandropsis pentaphylla*) we find a stalk (ANDROPHORE) between the corolla and the andrœcium, and also a stalk (GYNOPHORE) between the andrœcium and the pistil; in **jhumka-lata** (*Passiflora*) (see fig. 193) a stalk (GYNAN-

DROPHORE) bearing both the andrœcium and gynœcium; in **kanak-champa** or **mooch-kunda** (*Pterospermum acerifolium*) a stalk (gynophore) between the andrœcium and the pistil; in *Capparis sepiaria* a stalk (gynophore) bearing the pistil (fig. 75). Such stalks are nothing more than internodes, and are homologous with them. The occasional development

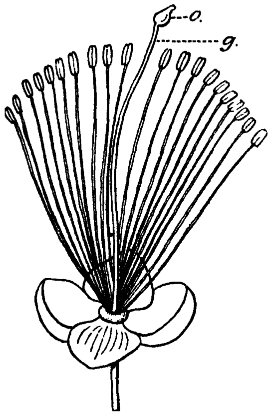


Fig. 75.—Kanta-gur-kamai (*Capparis sepiaria*)

o, Ovary. *g*, Gynophore.

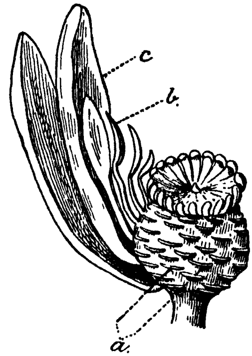


Fig. 76.—Shalook (*Nymphæa*) — acyclic flower with spirally-inserted floral leaves

a, Scars of stamens and perianth removed. *b*, Stamen. *c*, Perianth leaf.

of such internodes in flowers thus bears out the homology of flowers with shoots.

Again, we have learned that leaves are arranged on the axis of a shoot either spirally or in whorls. If the floral leaves are examined, they are also found inserted on the thalamus either spirally or in whorls, like the foliage leaves. For example, if we examine the flowers of **nag-phani, shalook** or **shafla** (fig. 76), and **padma** or Lotus we find that the sepals, petals, and stamens are arranged spirally on the thalamus; and we have found that in **kantali-champa** they are

arranged in whorls. Such a similarity between the arrangement of floral leaves on the thalamus and of foliage leaves on a shoot further bears out the homology of flowers with shoots. When the floral leaves, especially the sepals or petals, or both, are arranged spirally, the flower is said to be ACYCLIC; when they are arranged in whorls, the flower is said to be CYCLIC. The majority of flowers are cyclic, and only a small minority are acyclic.

Further, when the leaves on a shoot are in whorls, they are usually found to decussate. A similar decussation is met with in floral whorls. For instance, in **ata** and **kantali-champa** the calyx is the lowermost whorl of three sepals, and next above are two whorls of corolla of three petals each, the outermost whorl decussating with the calyx and the innermost whorl decussating with the outermost whorl of corolla. This is another evidence in support of the foliar nature of the whorls of flowers. This decussation of the whorls of flowers is known as ALTERNATION.

Ordinarily the sepals are green and the petals coloured, but, whether green or coloured, they have usually the structure and form of leaves, so that their foliar nature is quite obvious. It is only when we come to consider the stamens and carpels that their foliar nature becomes difficult to make out. In the case of stamens the difficulty vanishes if we examine first their parts, secondly, such flowers as **shalook** and **padma**, and, thirdly, what is known in gardening as the doubling of flowers. For example, a stamen ordinarily consists of a thin stalk surmounted by a comparatively broad portion, the latter divided in the middle by a middle line. The stalk corresponds to the petiole, the broad portion to the blade, and the middle line to the mid-rib of a leaf. In **shalook** and

padma the sepals gradually pass into petals, and petals into stamens, without that sudden break between them which is ordinarily met with in flowers. In cultivated flowers, such as Rose, Poppy, Pink, and **gandha-raj**, the petals are doubled or increased in number by the retrograde degeneration or conversion of stamens into petals; in fact, the petals increase in number at the expense of the stamens. In Wild Rose, Pink, and **gandha-raj** there are only five petals, and in Wild Poppy only four petals, whereas in garden specimens their number is very many. Among wild flowers, also, a sort of doubling is occasionally met with, as in **sarba-jaya** or Indian Shot (*Canna indica*) (see fig. 263), **halood** or Turmeric, **ada** or Ginger, and **dulal-champa** (*Hedychium coronarium*) (see fig. 262), where one or more petal-like structures intervene between the true petals and the stamen; these petal-like structures are metamorphosed stamens and are hence styled STAMINODIA. Again, in **sarba-jaya** the single stamen is also partially petaloid or petal-like. All these facts go to establish the foliar nature of the stamen. The foliar nature of the carpels is established by instances of cultivated flowers like those of Rose, in which the centre of the flower is often seen to be occupied by a number of green leaves where the carpels should be; in fact, the carpels are metamorphosed into and replaced by green leaves. In doubled **gandha-raj**, the style and stigma are often petaloid. The style is also petaloid in *Canna*. Flowers of *Brassica* (as **sharisha, phul-kapi**), *Sterculia* (as **jangli-badam**), *Triumfetta*, &c., have their pistils occasionally replaced by leafy organs. In **anaras** or Pine-apple the flowering axis, after giving rise to a close-set spike, which matures into an aggregate fruit (SOROSIS), occasionally **con-**

tinues to grow as a leafy shoot at the top of the fruit. The leafy shoot at the top of the fruit sometimes gives rise to another spike or fruit ending in a leafy shoot. This mode of growth, known as PROLIFERATION, is another proof of the identity of leafy and flowering shoots. In *Typha angustata* (**hogla**) the axis of the spike grows into a shoot, which latter ends in a second spike, so that there is a spike upon a spike (see fig. 269).

The function of the flower, as already stated, is reproduction, that is, the production of seeds from which new plants similar to their parents may arise. All parts of a flower have a bearing upon this function directly or indirectly. The stamens and pistils have a direct bearing, as without them no seeds can be produced, while the calyx and corolla have only an indirect bearing, in so far as they serve to protect and otherwise help the most essential parts of the flower, namely, the stamens and pistils. The stamens and pistils are therefore known as essential or reproductive organs, and the calyx and corolla as non-essential or helping organs. The helping organs may be absent without injury to the function of the flower, but the absence of the essential organs involves non-fulfilment of the function. In fact, there are many flowers which are wanting in the helping organs.

Flowers are known as DICHLAMYDEOUS when they have both the helping whorls, MONOCHLAMYDEOUS when only one helping whorl is present, and ACHLAMYDEOUS when both the helping whorls are absent. The first class of flowers is known as COMPLETE, and the last two classes INCOMPLETE. The two helping whorls together go by the name of PERIANTH, although the name perianth is usually restricted to the helping whorl or whorls when there is no distinction in colour between the two whorls or

where there is only one whorl. Flowers with both the essential whorls are said to be MONOCLINOUS or HERMAPHRODITE, or bisexual, or perfect; flowers with only one essential whorl DICLINOUS, unisexual, or imperfect. Diclinous flowers are either male, that is, staminate, or female, that is, pistillate. When the flowers on a plant are all unisexual, but some of them staminate and some pistillate, they are said to

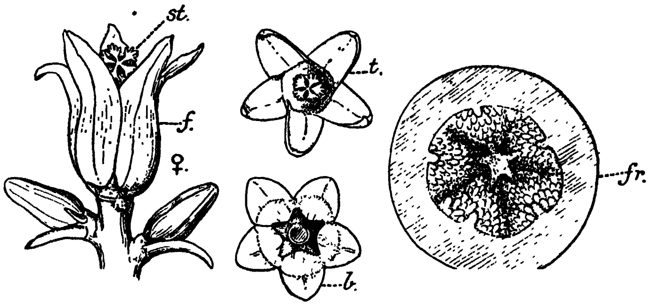


Fig. 77.—Panpe (*Carica Papaya*)

f, Female flower ♀. *t*, Seen from top. *b*, Seen from bottom. *st*, Stigma. *fr*, Section of fruit.

be MONŒCIOUS; and when the staminate and pistillate flowers are on separate plants of the same species, they are said to be DIŒCIOUS; when the flowers on the same plant are some bisexual and some unisexual, they are said to be POLYGAMOUS.

The flowers that have hitherto been mentioned are almost all hermaphrodite and dichlamydeous. The flowers of **shasha** or Cucumber, **belati-kumrha** or Gourd, **tarmuz** or Water-melon, **lal-bharenda** (*Jatropha gossypifolia*), **bag-bharenda** (*Jatropha Curcas*), Castor-oil (**rerhi**) plant (see fig. 233), are diclinous and monœcious; the flowers of **paṇpe** or Papaw (figs. 77, 78), **pituli** (see figs. 236, 237), **pan** or Betel-leaf

plant, **palang-shag** or Spinach, **chuprhi-aloo**, **kia** (*Pandanus*), **ganja** or Hemp, **tal** or Palmyra-palm, **khejur** or Date-palm, **shaorha** (*Streblus asper*), are diclinous and diœcious. The flowers of Castor-oil and **krishna-kali** are monochlamydeous, and those of **rang-chita**, **pan**, **kia**, and **kachu** achlamydeous. The flowers of **amrha**, **lichoo** or Litchi, **gab**, **jungli-badam** (*Sterculia fœtida*), **sundri** (*Heritiera minor*), and **hijli-badam** or Cashew nut are polygamous.

Fig. 78.—Papaw—male flowers

CHAPTER XIII

THE FLOWER—PART II: THE HELPING WHORLS

CALYX.—The calyx is the outermost whorl of the perianth. The leaves, called sepals, of which it is formed are usually green. Occasionally they are coloured, and when coloured the calyx is said to be PETALOID or petal-like (see Plate V, B). When all the sepals of a calyx are equal or nearly so in shape and size, the calyx is said to be REGULAR; when they are unequal in shape and size, the calyx is said to be IRREGULAR. When the sepals are wholly distinct or free from one another, the calyx is called POLYSEPALOUS; when they are coherent or joined with one another, the calyx is called GAMOSEPALOUS. In a gamosepalous calyx the cohesion between the sepals seldom extends over the whole length; the lower portions usually unite, forming the TUBE, and the upper portions remain free, and are called the LIMBS. When the

limbs are short, they are spoken of as TEETH. In a gamosepalous calyx the number of sepals is determined by counting its limbs or teeth.

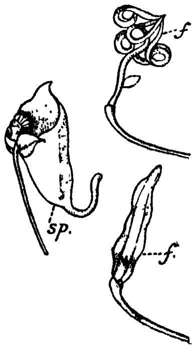


Fig 79 —Dopati (*Impatiens Balsamina*)

sp, Spur. *f*, Unripe fruit. *f'*, Fruit bursting.

The gamosepalous regular calyx may assume various forms, of which the following are very common, namely: TUBULAR (see fig. 215), as in **dhutura, taru-lata** (*Quamoclit pinnata*); CAMPANULATE or bell-shaped, as in **jaba** or Chinese Rose. The calyx, whether gamosepalous or polysepalous, is often rendered irregular when its base is prolonged into a pouch or sac. If the pouch is short, the calyx is said to be GIBBOUS, as in Mustard; when the pouch is long and tapering, the calyx is said to be SPURRED (fig. 79), as in **dopati** (*Impatiens Balsamina*), Garden Nasturtium, and Larkspur.

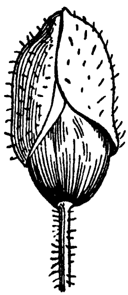


Fig. 80.—Caducous Calyx (Poppy)

The calyx is said to be CADUCOUS when it falls off as soon as the flower begins to expand, as in Poppy (fig. 80) and **shial-kanta**; DECIDUOUS when it falls off along with the petals after the flower expands, as in most flowers; PERSISTENT when it does not fall off, but persists as a part or covering of the fruit, as in **tulsi**; and ACCRESCENT when it is not only persistent, but also grows along with and forms part of the fruit, as in **begoon, sal** (see fig. 165), **sagoon,** and **chalta** (*Dillenia indica*). Sometimes the calyx consists of a circle

of hairs or bristles, as in **kukur-songa** or **kukshima**, and such a hairy calyx is known as PAPPUS (fig. 81).

When the calyx is inserted on the thalamus directly, so that it is the lowest whorl of a flower, it is said to be INFERIOR with respect to the pistil, which is the highest whorl, and is therefore said to be SUPERIOR. In some cases, to be explained later on, the calyx seems to grow from the top of the pistil, when it is said to be superior in respect of the pistil, which in that case is inferior.

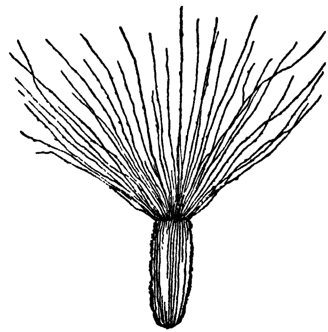


Fig. 81.—Achene with Pappus

In some flowers, as in **jaba** and Cotton (see fig. 167), there is a whorl of green leaves below the calyx. This whorl of green leaves is usually known as EPICALYX or whorl of bracteoles. Usually a flower originates in the axil of a bract or bracteole. The side of a flower which is turned towards the bract or bracteole is said to be ANTERIOR, and the side turned away from it is said to be POSTERIOR.

COROLLA.—Corolla is the inner whorl of the perianth. The leaves, called petals, of which it is composed differ from the foliage leaves more than the sepals in colour, form, and structure. As a rule the petals are more or less brightly coloured, and serve to attract insects and birds to visit flowers. Hence the corolla is often called the ATTRACTIVE whorl. Occasionally the petals are green, like sepals, then they are called SEPALOID or sepal-like. The petals are usually narrower near their base, or even have a

petiole-like portion called CLAW, as in Mustard and Garden Nasturtium.

The corolla, like the calyx, may be free or POLYPETALOUS, as in Poppy, **shial-kanta**, and Radish; or it may be coherent or GAMOPETALOUS, as in Datura, **juin** (*Jasminum*), **sheuli** (*Nyctanthes*), and **kalmi-shag.** Whether poly- or gamopetalous, the corolla is said to be regular or irregular according as the petals are equal or unequal in size and form. In practice a flower is said to be regular or irregular according to the regularity or irregularity of the petals, irrespective of the regularity or irregularity of the calyx or other whorls.

The commonly occurring forms of polypetalous regular corolla are (fig. 82): (1) CRUCIFORM—A, when four petals, each with a claw, are inserted diagonally or crosswise on the thalamus, as in Mustard and Radish; (2) ROSACEOUS, when the petals are spreading and inserted on the thalamus with a broad base, as in Rose; (3) CARYOPHYLLACEOUS—B, when there are five petals with long claws and spreading limbs, as in Pink and **amrul.** A polypetalous irregular corolla has one specially noticeable and common form, namely, PAPILIONACEOUS—C (see fig. 97), when there are five petals of which one is considerably larger than the rest, posterior and exterior, and is known as VEXILLUM or standard or banner; two lateral and smaller ones called ALÆ or wings; and two anterior ones called KEEL or CARINA, as in Pea, **bak** (*Sesbania grandiflora*), and in fact in all the Pulse family of plants. In all flowers with papilionaceous corolla the posterior and exterior vexillum wholly encloses all the other petals in the bud state.

The common forms of gamopetalous regular corolla are: (1) TUBULAR—D, as in the disk florets of **surya-**

mukhi or Sunflower, and **gendha**; (2) CAMPANULATE or bell-shaped—E, as in **tepari** (*Physalis*), **bhuin-kumrha** (*Ipomœa paniculata*), **kalmi-shag** (*Ipomœa reptans*); (3) INFUNDIBULIFORM or funnel-shaped—F, as in Datura, Tobacco, **kalika-phul**; (4) HYPOCRA-

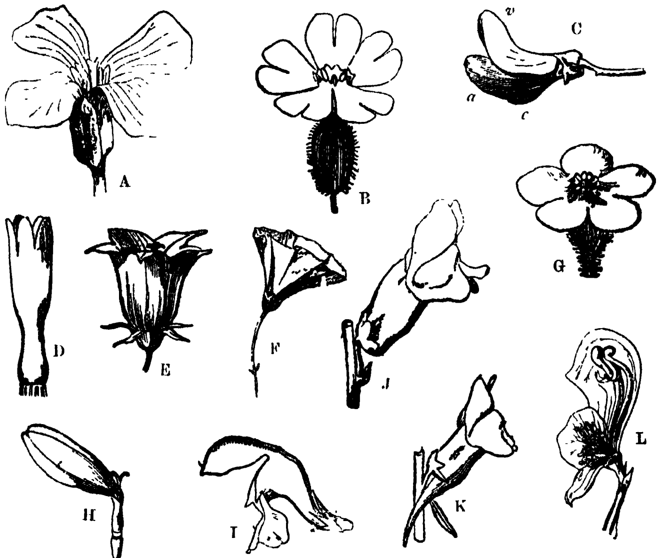


Fig. 82.—Forms of Corolla

A, Cruciform. B, Caryophyllaceous. C, Papilionaceous. D, Tubular. E, Campanulate. F, Funnel-shaped. G, Rotate. H, Ligulate. I, Bilabiate. J, Personate. K, Personate and spurred. L, Nectaries.

TERIFORM or salver-shaped, as in **taru-lata** (*Quamoclit pinnata*), **rangan** (*Ixora parvifolia*), **sheuli** (*Nyctanthes Arbor-tristis*), **juin** (*Jasminum auriculatum*), Vinca; (5) ROTATE or wheel-shaped—G, as in **lanka** (*Capsicum*), **begoon**, and **akanda**; and (6) URCEOLATE (see fig. 202) or jug-shaped.

The common forms of gamopetalous irregular corolla are: (1) BILABIATE or two-lipped—I, as in **tulsi**, **bakas**

(*Adhatoda Vasica*), and **kule-kharha** (*Hygrophila spinosa*); (2) PERSONATE—J, when the throat of a bilabiate corolla is closed by a projecting pouch of the lower lip, as in Snapdragon and *Lindenbergia urticifolia*; (3) LIGULATE or strap-shaped—H, as in the ray florets of the Sunflower. The corolla, like the calyx, may also be spurred—K.

The terms used in describing the forms of corolla are also applicable in describing the forms of calyx.

In some flowers there is on the throat of the calyx-tube or corolla-tube a ring of slender filaments, as in **jhumka-lata** (see fig. 193, *b*), or a petaloid membranous ring, as in *Pancratium*, or lobed columnar or petaloid process partially or wholly adherent to the staminal column, as in **akanda** (see fig. 208). These structures are known by the name of CORONA. The ligular membrane attached to the face of free petals, as in Pink, may also be classed with corona.

The corolla, like the calyx, may be inserted directly on the thalamus, as in Poppy, or on the top of the pistil (ovary), as in **pyara** or Guava, and is said to be HYPOGYNOUS (below the pistil) or EPIGYNOUS (above the pistil) respectively. In some flowers, as in Rose, Pea, **bak-phul**, and **jarool** (*Lagerstrœmia*), the calyx is inferior and the corolla is inserted on the throat of the calyx-tube; the corolla then is said to be PERIGYNOUS or round about the pistil. The terms hypogynous and epigynous are often replaced by the terms inferior and superior respectively.

From the nature of their origin we have learnt that the calyx, corolla, stamens, and pistil must be inserted directly and in an acropetal order on the axis or thalamus, so that the calyx should always be inferior, the corolla and the stamens hypogynous, and the pistil superior. In fact, such is the construction of flowers

like those of Poppy, **champa, ata,** Mustard, &c., and flowers constructed like these are said to be HYPOGYNOUS FLOWERS (fig. 83—H). But in some flowers, as in Rose, Pea, and **bak**, the basal portion of the thalamus on which the calyx is inserted grows more or less like a cup, forming the so-called CALYX-TUBE, and the petals and stamens are inserted on the throat of the calyx-tube, so that they seem to grow round about the pistil and not from the thalamus. Flowers

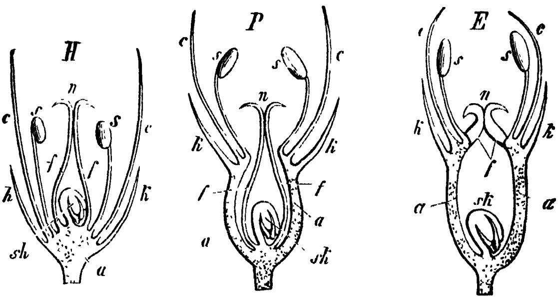


Fig. 83. Diagram of H, Hypogynous, P, Perigynous, and E, Epigynous Flowers

a, Thalamus. *k*, Calyx. *c*, Corolla. *s*, Stamens. *f*, Carpels. *n*, Stigma. *sk*, Ovule

constructed in this fashion are termed PERIGYNOUS FLOWERS—P. There is a third class of flowers, as **pyara, jamrul, shasha, kumrha, dhania,** and **rajanigandha,** in which the calyx-tube—that is, the cup-shaped growth of the basal portion of the thalamus—wholly surrounds the lower portion of the pistil (ovary) and adheres to its wall, so that the calyx, corolla, and stamens all seem to grow from the top of the ovary. Flowers constructed in this fashion are termed EPIGYNOUS FLOWERS—E. In epigynous flowers, therefore, the calyx, corolla, and stamens are superior, while the ovary is inferior. In epigynous

and perigynous flowers there seems at first sight to be a departure from the acropetal order of growth of the floral leaves, but that this departure is only apparent and not real will appear from what has been stated above.

The use of the term perianth has already been explained. It is said to be POLYPHYLLOUS (many-leaved) when the segments are free, and GAMOPHYLLOUS (one-leaved) when the segments are connate.

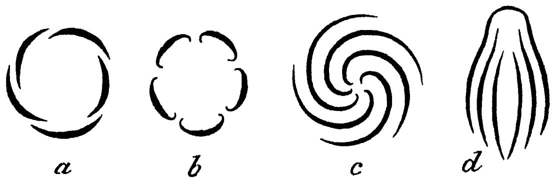


Fig. 84.—Æstivation o i lowers

a, Imbricate. *b*, Valvate. *c*, Contorted or twisted. *d*, Vexillary.

The vernation of sepals and petals in a flower-bud is described in very much the same terms as are used in the description of the leaves in a leaf-bud. Thus the petals may be: (1) VALVATE—*b* (fig. 84), as in **ata, nona, kantali-champa**; (2) IMBRICATE—*a*, as in Mustard and Poppy; (3) PLICATE, as in **begoon** and **kalmi-shag**; (4) TWISTED or CONTORTED—*c*, as in **jaba, natkan** (Anatto), **karabi**, and **kalika-phul**; (5) CRUMPLED, as in Poppy and **shial-kanta**; or (6) VEXILLARY—*d*, as in Pea. The term vernation or prefoliation is usually restricted to the description of leaf-buds, and the term ÆSTIVATION or prefloration is used in the description of flower-buds.

CHAPTER XIV

THE FLOWER.—PART III: REPRODUCTIVE ORGANS

ANDRŒCIUM.—The stamens, which collectively go by the name of andrœcium, are the organs which bear the male or fertilizing cells known as POLLEN-GRAINS or MICROSPORES. Each stamen (fig. 85) consists usually of a slender stalk, called FILAMENT—F, which corresponds to the petiole of a leaf, and an expanded

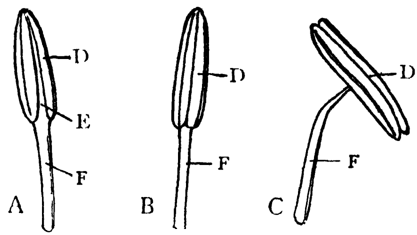


Fig. 85.- Stamens. A, Adnate or dorsifixed. B, Innate or basifixed. C, Versatile. D, Anther. E, Connective. F, Filament.

head, called ANTHER—D, which corresponds to the blade of a leaf. Like the blade the anther is divided into two longitudinal halves, called LOBES, by a midrib, called the CONNECTIVE, which is usually grooved in the upper surface or face (ventrum) of the anther, and ridged on the lower surface or back (dorsum), as in leaves. The mode of attachment of the filament to the anther varies in different plants: thus it is (1) INNATE or basifixed—B when the filament is attached to the base of the anther so that the connective is the direct prolongation of the filament, as in Poppy and Mustard; (2) ADNATE or dorsifixed—A when the filament is attached to the connective at the back of the anther, as in **dulee-champa** (*Magnolia*); and (3) VER-

SATILE—c when the point of attachment in an adnate anther is so fine that the anther turns upon the point freely as on a pivot, as in Grasses, **amrul-shag**, and **kul.** When the face of the anther is turned towards the centre or inside of the flower, it is said to be INTRORSE, as in **champa**; when turned towards the outside of the flower, it is said to be EXTRORSE, as in **ulat-chandal** (*Gloriosa superba*).

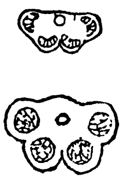


Fig. 86. Transverse Section of Young Anthers

The anther contains within it usually four chambers or loculi, called POLLEN-SACS or MICROSPORANGIA (fig. 86), two in each anther-lobe. These sacs or sporangia are usually full of a mass of minute cells called POLLEN-GRAINS or MICROSPORES, mentioned above. In **akanda** and other members of the same family, as well as in Orchids, the pollen-grains within a pollen-sac cohere together, forming one or two pollen-masses known as **pollinia** (fig. 87). Each pollinium is usually provided with a stalk, called CAUDICLE. The pollinia are usually in pairs, attached by the lower ends of their caudicles to a DISK, so that on the dehiscence of the anthers they come out in pairs, as in **akanda** (see fig. 208).

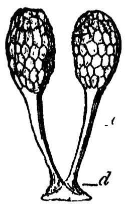


Fig 87. —Pollinia (*Orchis*)

c, Caudicle.
d, Disk.

As in the case of petals, the stamens may be hypogynous or inferior, as in **shial-kanta**; or perigynous, as in Rose, **jarool**, and **kal-kashunda**; or epigynous or superior, as in **pyara** and **jamrul.** It should be noted here that the terms COHESION and ADHESION are used in science in a restricted sense. Cohesion means the union of similar parts, that is, parts of the same organ, while adhesion means the union of dis-

similar parts, that is, parts of different organs. For example, the union of a sepal with a sepal, of a petal with a petal, and of a stamen with a stamen, are instances of cohesion; while the union of a stamen with a corolla, and of a petal with a calyx, are instances of adhesion.

COHESION AND LENGTH OF STAMENS.—The stamens may be either free or coherent (fig. 88).

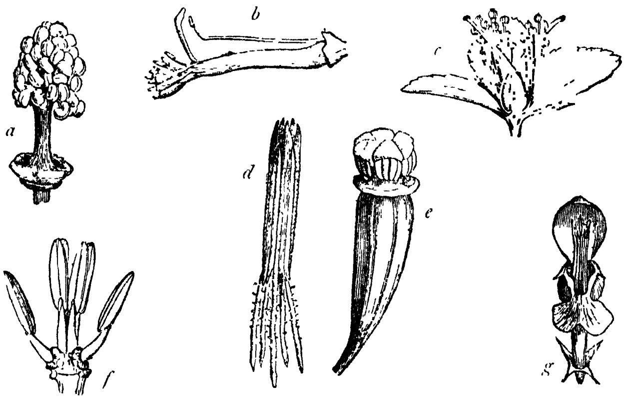


Fig. 88.—Stamens

a, Monadelphous. *b*, Diadelphous. *c*, Polyadelphous. *d*, Syngenesious. *e*, Gynandrous. *f*, Tetradynamous. *g*, Didynamous.

Coherent stamens are either MONADELPHOUS—*a*, as in **jaba**; or DIADELPHOUS—*b*, as in Pea; or POLYADELPHOUS—*c*, as in Orange, Castor-oil, and **kajupati** oil-yielding plant (*Melaleuca*) and *Hypericum* (see fig. 160), when the stamens cohere by their filaments to form either one, two, or more than two bundles, the anthers remaining free. When the stamens cohere by their anthers, the filaments remaining free, they are said to be SYNGENESIOUS—*d*, as in Sunflower and **gendha**. When there are four free stamens, of which two are long and two short, they

are said to be DIDYNAMOUS—*g*, as in **tulsi.** When there are six free stamens, of which four are long and two short, they are said to be TETRADYNAMOUS —*f*, as in Mustard.

ADHESION OF STAMENS.—When the stamens adhere to the corolla-tube, so that they seem to arise from the latter, they are said to be EPIPETALOUS (see fig. 215, *b*), as in Datura and most flowers with a gamopetalous corolla. When the stamens adhere to the pistil, they are said to be GYNANDROUS—*e*, as in **akanda, işher-mul** (see also figs. 116 and 208, *st.a.*), and **rasna.**

DEHISCENCE OF ANTHER.—Pollen-grains or microspores, as mentioned above, lie enclosed in the two anther-lobes within four pollen-sacs. As the anther matures the two pollen-sacs in each lobe of the anther usually coalesce to form one sac, and the pollen-grains still lie enclosed within the sac. The pollen-grains, which are the male cells, must be brought into contact with the female cell, which in its turn lies enclosed within the pistil. Without this contact of the male cell with the female one, and their subsequent fusion, no seeds are produced, and without seeds, as you know, there can be no reproduction. For the purpose of reproduction, therefore, the first step that is necessary is the DEHISCENCE or bursting of the wall of the pollen-sacs so as to set free or shed the pollen-grains; the next step is POLLINATION, or carrying the liberated pollen-grains to the pistil which bears within it the female cell; and, lastly, FERTILIZATION, or the fusion of the male cell with the female cell, which results in the formation of seeds. With regard to dehiscence of the anther, the following modes are common: the anther, or rather the wall of the pollen-sac, dehisces either (1) LONGITUDINALLY

along the whole length of the anther-lobe, as in **jaba, ata,** and **champa**; or (2) by a SLIT along a portion only of the length of the anther-lobe, as in **pana, ghet-kachu,** and **gaja-pipul**; or (3) by PORES, that is, small holes usually on the top of the anther-lobes, as in **natkan, chalta,** and **begoon**; or (4) by VALVES, when a part of the wall of the sac opens like a valve or lid, as in **tezpat** flowers and other flowers of the Lauraceæ family (see fig. 244, *a*). Of these forms of dehiscence the longitudinal is the most common, and it is said to be introrse, extrorse, or lateral according as the dehiscing line is towards the face, back, or side of the anther.

In certain flowers some stamens are seen with anthers and others without them; the former are known as FERTILE stamens and the latter STERILE or barren. The sterile stamens are known as STAMINODIA, as in **bakul** (*Mimusops Elengi*) (see fig. 203), and in **mooch-kunda,** or **kanak-champa** (*Pterospermum acerifolium*). In **sarba-jaya** (see fig. 263), **bhuin-champa** (*Kæmpferia rotunda*), and **dulal-champa** (see fig. 262) the staminodia have the form of petals, and are therefore called petaloid.

GYNŒCIUM OR PISTIL.—This is the last whorl of a flower, and is intended to produce the female cell known as the OOSPHERE, OVUM or EGG-CELL. The oosphere remains enclosed in another cell, called the EMBRYO-SAC OR MACROSPORE, which latter again remains enclosed in a structure called the OVULE or MACROSPORANGIUM. The ovules or macrosporangia are destined to form the seeds. Bisexual flowers are therefore also known by the name of AMBI-SPORANGIATE, because they bear both the micro-sporangia or pollen-sacs and the macrosporangia or ovules.

The component parts of a pistil are known as CARPELS. The carpels, like all other segments of a flower, are modified leaves. The leaf, in forming a carpel, is folded in such a way that it forms a closed chamber, termed OVARY (fig. 89), terminating in a slender filament, termed STYLE, the apex of which is usually rounded or discoid and termed STIGMA. When the style is wanting, the stigma is said to be

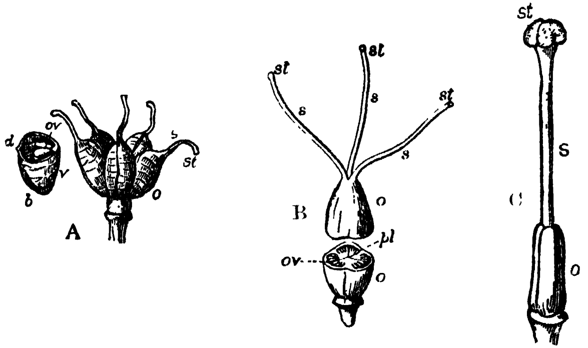


Fig. 89.—Forms, &c., of Pistil

A, Apocarpous. B, C, Syncarpous. *o*, Ovary; *s*, styles; *st*, stigma; *pl*, placenta; *ov*, ovules; *d*, dorsal, and *v* ventral sutures.

sessile. The ovary encloses one or more ovules, which, as already mentioned, are destined to form seeds, and the ovary when mature is known as the fruit. In the majority of flowering plants the carpellary leaf forms a closed chamber, the ovary, enclosing the ovules and seeds within. These flowering plants are therefore known as ANGIOSPERMIA or covered-seeded plants, as opposed to a small minority of flowering plants in which the ovules and seeds are produced on open carpels, that is, not enclosed within ovaries. These latter are therefore known as GYMNOSPERMIA or open-seeded plants (see fig. 278, *o*).

The carpels constituting a gynœcium may be free from one another or more or less coherent. When the carpels are free from one another the pistil is said to be APOCARPOUS; when they are coherent, the pistil is said to be SYNCARPOUS. An apocarpous pistil is simple or multiple according as the number of carpels is one or more than one. The pistil of Pea, for example, is apocarpous simple, and that of **kantali-champa** apocarpous multiple, while that of Orange is syncarpous. If you make a cross-section of an Orange, you will find that it discloses several chambers corresponding to the number of carpels that have united together to produce the pistil or fruit. The cross-section of a Pea similarly discloses one chamber corresponding to one carpel forming the pistil or fruit. In a syncarpous pistil the cohesion of the carpels may exist either throughout their whole structure, including the ovary, style, and stigma, as in Orange; or in the region of the ovary and style only, the stigma remaining free, as in **jaba**; or in the region of the ovary only, the style and stigma remaining free (see figs. 160, 161), as in **mashina** or **tishi** or Linseed, **chita** (*Plumbago*), *Hypericum*, and Pink; or in the region of style and stigma, the ovaries only remaining free, as in **karabi**, *Vinca* (see fig. 206, *b*), and **akanda**. From the number of the stigmas, or of both stigmas and styles, the number of carpels of which a syncarpous pistil is composed is usually inferred. For example, in **jaba** there are five stigmas, from which we infer that the pistil is composed of five carpels; in **tishi** or Linseed there are five styles and five stigmas, and we infer that the pistil is composed of five carpels. Even when the cohesion is complete, as in Mustard and **kalmi-shag**, the number of lobes of the stigma indicates the number of

carpels, the pistil in both being composed of two carpels.

The manner in which the carpellary leaves cohere with one another to give rise to the syncarpous condition is different in different classes of plants. The carpellary leaves which stand in a whorl may cohere by the adjacent margins, so as to form one ovary with one chamber or cell, the lines of junction or SUTURES of the carpellary leaves being as many as the number of the leaves. These sutures are usually marked on the outer surface of the wall of the ovary by a line or groove, and on the inner surface of the wall by a more or less projecting structure. These projecting structures inside the ovary are known by the name of PLACENTA, and these placentas are destined to bear ovules. If we make a cross-section of the ovary or fruit of a Papaw (see fig. 77), we find that the ovary is composed of three to five carpels, is syncarpous, one-celled or unilocular, with three to five placentas on the inner surface of the wall bearing ovules. Similarly, if we examine the ovary of **jhumka-lata** or Passion Flower, we find the same thing, namely, that it is composed of three carpels, is syncarpous, unilocular, with three placentas on the inner wall bearing ovules. The ovary of **natkan** or Anatto discloses that it is composed of two carpels, and is syncarpous, unilocular, with two placentas on the inner wall bearing ovules. If the placentas are on the wall of the ovary, as in the instances given above, they are said to be PARIETAL (on the wall) (fig. 90), and such a mode of placentation is called parietal placentation. Besides the sutures

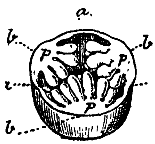


Fig. 90.—Transverse Section of a One-celled Ovary with Parietal Placentation

a, Dorsal suture.
b, Ventral suture.
p, Placenta,

mentioned above, marking the lines of junction of the carpellary leaves, there are other lines or sutures which mark the mid-ribs of the carpellary leaves. The latter sutures are known as the DORSAL or back sutures, and the former as VENTRAL or face sutures (see fig. 90). These sutures are very prominent on the fruit or pod of Pea (fig. 91). They are two in number, one ridged or keeled and the other grooved. The grooved suture, *v*, is ventral, as inside it lies the placenta bearing seeds, and the keeled suture, *d*, is dorsal. When we shell the pod we generally do it along the dorsal suture.

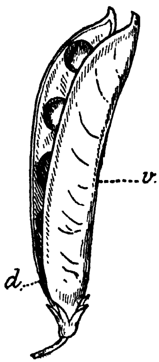


Fig. 91.—Pod (legume) of Pea

v, Ventral suture.
d, Dorsal suture.

When the parietal placentas project considerably inwards towards the centre of the ovary, without meeting and cohering in the centre, the ovary is said to be CHAMBERED, as in Poppy, **shial-kanta,** and *Orobanche*. If, however, the projecting placentas meet and cohere in the centre of the ovary, the ovary no longer remains one-celled, but becomes divided into as many cells or loculi as there are carpels, and the placentas no longer lie on the wall, but come to the centre of the ovary, where they cohere. Such ovaries are then syncarpous, multilocular, with AXILE or central placentation (fig. 92), as in Orange, Lemon, **dhanrhas** (*Hibiscus esculentus*). The partition walls

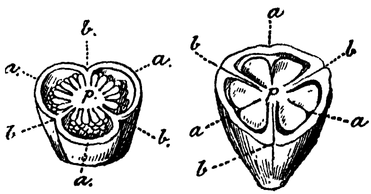


Fig. 92.—Transverse Section of Three-celled Ovary with Central or Axile Placentation

a, Dorsal suture. *b*, Ventral suture.
p, Placenta.

between the cells or loculi of such an ovary are known as DISSEPIMENTS or SEPTA, which, from the very nature of their origin from the union and subsequent projection of the two margins of two adjacent carpellary leaves, must be double. Occasionally the number of loculi in an ovary becomes increased by the growth of false dissepiments from the wall of the ovary to the placenta. In Datura, for example, the ovary, which is originally two-celled with a central placenta, becomes subsequently four-celled by the growth of a dissepiment across each cell. Such dissepiments, from the nature of their origin, cannot be double, but must be single, and are hence known as SPURIOUS or false. In Mustard (fig. 93) and allied plants the ovary is composed of two carpels, syncarpous, originally one-celled with two parietal placentas, but subsequently becomes two-celled by a false septum thrown across the ovary from one placenta to the other. In these plants the false septum has got the special name of REPLUM—*r*. In Pink and allied plants the ovary is syncarpous, one-celled, with a central axis which is free from the wall of the ovary, and on which the ovules are inserted. Such a kind of placentation is known as FREE-CENTRAL (fig. 94), and is supposed to arise from the early dissolution of the dissepiments, so that the originally many-celled ovary with axile placentation is rendered one-celled with free-central placentation. In **patari** (*Polygonum*) or **pani-marich**, (*Rumex*), where the ovary is one-celled, with one or more ovules arising from the base of the ovary, it is

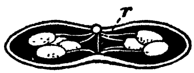


Fig. 93.—Transverse Section of Silicula
r, Replum.

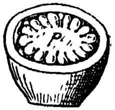


Fig. 94.—Transverse Section of an Ovary with Free-central Placentation

believed that the placenta, which is basal, is the apical continuation of the axis or thalamus inside the ovary. Such a placentation is usually included under the head of free-central. In *Nymphæa* or **shalook** and *Butomopsis lanceolata* (see fig. 256, *sp*), a common aquatic marsh plant, ovules are inserted all over the inner wall of the ovary. The placentation in such cases is said to be SUPERFICIAL. In an apocarpous simple pistil, e.g. Pea, or multiple pistil, e.g. **akanda** and **champa**, the placenta lies inside the ventral suture, and is therefore said to be VENTRAL (see fig. 91).

THE OVULE OR MACROSPORANGIUM.—The ovule arises as a small bud or mass of tissue from the placenta. As the bud develops it gradually becomes thick and rounded at its apex and thin at its base, till the thick apical portion, now called the NUCELLUS, is separated from the placenta by a short thin stalk called the FUNICLE. From the funicular end of the nucellus one or more, usually two, coats or integuments begin to grow and gradually envelop the nucellus, excepting a small portion of it opposite to the funicular end, which is thus left open or free from integuments. This open or uncovered part of the nucellus is known as the MICROPYLE (small gate). The funicular end of the nucellus from which the coats grow is known as the CHALAZA. Within the nucellus, close to the micropylar end, is developed a single cell, called the EMBRYO-SAC OR MACROSPORE, which encloses within it the oosphere, ovum, or female cell, mentioned before. In rare cases the nucellus remains naked, or without coats.

Ovules are usually divided into three classes: (1) ORTHO- or A-TROPOUS (straight)—A, in which, as described above, the chalaza lies nearest to the placenta, and the micropyle farthest from it; (2) ANA-

TROPOUS (inverted)—B, in which, owing to the excessive growth in length of the funicle, the ovule becomes top-heavy, and the nucellus, in consequence toppling over, becomes inverted, and the elongated funicle adheres to one side of the nucellus and grows along with the integuments, forming a sort of ridge on the wall of the ovule, known as RAPHE, and owing to the inverted position of the nucellus, the micropyle and the chalaza change their position with respect to

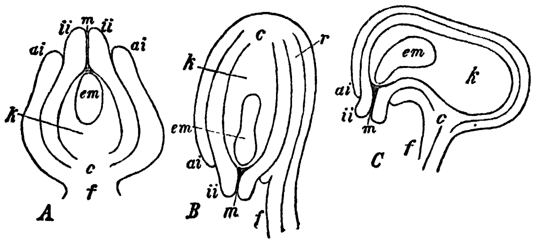


Fig. 95.—Ovules

A, Orthotropous. B, Anatropous. C, Campylotropous. *k*, Nucellus; *ai*, outer, *ii*, inner coat; *m*, micropyle; *f*, funiculus; *c*, chalaza; *em*, embryo-sac; *r*, raphe.

the placenta; and (3) CAMPYLOTROPOUS (horseshoe-shaped)—C, when the nucellus is bent like a horseshoe, so that the chalaza and the micropyle, though lying at the opposite end of the nucellus, as in orthotropous form, are nearly at the same distance from the placenta.

The position of the ovule within the ovary is different in different plants. Thus it may be ERECT, that is, stand upright from the base of the ovary as in Sunflower; or SUSPENDED, that is, hang down from the top of the ovary; or PENDULOUS, that is, hang down from the side of the ovary; or ASCENDING, that is, turn upwards from the side of the ovary; or HORIZONTAL, that is, arise from the side of the ovary and look neither upwards nor downwards, but sideways.

ISOMERITY OF FLOWERS.—When the calyx, corolla, andrœcium, and gynœcium of a flower consist of the same number of segments, or some multiple of that number, the flower is said to be ISOMEROUS. Otherwise it is ANISOMEROUS. An isomerous flower may be DIMEROUS, TRIMEROUS, TETRAMEROUS, or PENTAMEROUS, according as the number of segments in each whorl is 2, 3, 4, or 5, or some multiple of them. Common instances of an isomerous flower are **patharkucha** (*Bryophyllum calycinum*) and **him-sagar** (*Kalanchoe*) (see fig. 183), in both of which there is one whorl of calyx with four sepals, one whorl of corolla with four petals, two whorls of andrœcium with four stamens in each whorl, and one whorl of pistil with four free carpels. Such all-round isomerity is rare amongst Dicotyledons. Usually the number of segments in all whorls, excepting the pistil, is taken into account in determining the isomerity of a flower, as the number of segments of the pistil is, as a rule, less than the number of segments of the other whorls.

SYMMETRY OF FLOWERS.—A flower is said to be SYMMETRICAL when it can be divided by one or more vertical planes, passing through its centre, into two equal and similar halves, while a flower which cannot be so divided is said to be ASYMMETRICAL. Symmetrical flowers are monosymmetrical or ZYGOMORPHIC when they can be divided into two equal and similar halves by one such vertical plane only, as in Pea; and polysymmetrical or ACTINOMORPHIC when they can be so divided by two or more such vertical planes, as in **rajani-gandha** or Tuberose.

FLORAL DIAGRAMS.—The number, arrangement, and nature of the whorls of a flower and of their segments is often represented by a diagram known as FLORAL DIAGRAM. In a floral diagram the successive

whorls and their segments are shown on a series of concentric circles, as in fig. 96. In this figure the dot at the top of the diagram represents the axis on the side of which the flower is borne, so that the side of the diagram nearest to the dot represents the POSTERIOR part of the flower, and the side farthest from the dot the ANTERIOR part. The vertical plane passing through the centre of the diagram and through the dot is known as the MEDIAN PLANE (m, m'), which divides the flower into two equal and similar halves, right and left. The vertical plane passing through the centre and cutting the median plane at right-angles is known as the LATERAL PLANE (l, l), which divides the flower into two equal and similar halves, posterior and anterior. The two vertical planes which bisect the angles formed by the median and lateral planes are known as the DIAGONAL PLANES (d, d; d', d'), each of which divides the flower into two equal and similar halves. Thus the diagram represents a polysymmetrical or actinomorphic complete hermaphrodite flower.

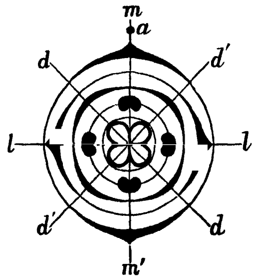


Fig. 96.—Floral Diagram

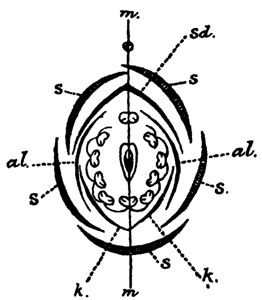


Fig. 97.—Diagram of Papilionaceous Flower (zygomorphic)

m, Median plane. *s*, Sepals *sd*, Standard. *al*, Alæ. *k*, Keel.

Similar diagrams may be constructed of monosymmetrical or zygomorphic flowers, as in fig. 97. The diagrams further indicate whether the segments of a whorl are free or coherent, and also whether they

are valvate or imbricate. Such floral diagrams are said to be EMPIRICAL, as they represent the actual condition of flowers. When a diagram shows not only the parts of a flower actually present, but also suppressed parts, it is said to be THEORETICAL. The suppressed parts are represented in the diagram by dots to show the normal position of the absent parts (fig. 98).

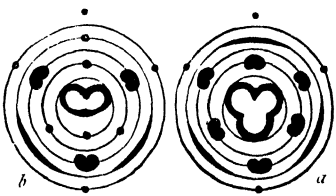


Fig. 98.—Floral Diagrams

a, *Bambusa*. *b*, Ordinary type of grass.

FLORAL FORMULÆ.—The number, cohesion, and adhesion of the segments of a flower may also be represented by a FORMULA (fig. 99). Thus the formula K_{2+2}, C_4, A_{2+4}, $G^{(2)}$ represents the structure of the flower of Mustard; K_{2+2} indicates that the calyx consists of four sepals, arranged in two whorls of two each, and that it is polysepalous and inferior; C_4 indicates that the corolla consists of four petals in one whorl, and that it is polypetalous and hypogynous; A_{2+4} indicates that the andrœcium consists of six stamens, arranged in two whorls, two in the outer and four in the inner whorl, and that they are free and hypogynous; and $G^{\underline{(2)}}$ indicates that the gynœcium consists of two carpels in one whorl, and is syncarpous and superior.

Fig. 99.—Floral Diagram of Cruciferæ

Compare the formula with the floral diagram (fig. 99). The formula $K(5)$, $|C_{(5)}, A_5|$, $G^{\underline{(2)}}$ represents the structure of the flower of Datura, namely, the flower has one whorl of calyx with five sepals, gamosepalous, inferior; one whorl of corolla with five

petals, gamopetalous, hypogynous; one whorl of andrœcium with five stamens, free and epipetalous; and one whorl of gynœcium with two carpels, syncarpous, superior. The formula $|\underline{P_{3+3}, A_{3+3}}|, G_{\overline{(3)}}$ represents the structure of the flower of **rajani-gandha**, namely, the flower has a perianth of two whorls of three leaves each, gamophyllous, superior; andrœcium of two whorls of three stamens each, free, superior; and one whorl of gynœcium of three carpels, syncarpous, inferior. Compare this formula with the floral diagram (fig. 100).

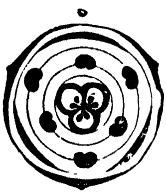


Fig. 100.- Floral Diagram of Liliaceæ

CHAPTER XV

POLLINATION

The first step towards reproduction is POLLINATION, which is the process of bringing the pollen-grains in contact with the stigma in Angiospermia, and with the ovules in Gymnospermia. When the pollen-grain of a flower reaches the stigma or ovule of the same flower, the process is known as SELF-POLLINATION or AUTOGAMY. On the other hand, when the pollen-grain of a flower reaches the stigma or ovule of another flower of the same species, whether on the same plant or on a different plant, the process is known as CROSS-POLLINATION or ALLOGAMY.

An examination of the structure of flowers reveals the fact that flowers may be arranged into several groups according to the nature of their pollination.

First, UNISEXUAL FLOWERS. These must be cross-

pollinated, and there is no possibility of self-pollination.

Second, DICHOGAMOUS FLOWERS. In hermaphrodite or bisexual flowers, from the proximity of the stamens to the pistil, it is natural to suppose that these flowers are self-pollinated. But on a closer examination it is found that in several hermaphrodite flowers the two sexes mature at different times, so that the chances of self-pollination are wholly eliminated. Flowers of this nature are described as DICHOGAMOUS. They are either PROTANDROUS or PROTOGYNOUS, according as the andrœcium or gynœcium ripens first.

Third, HOMOGAMOUS AND HERKOGAMOUS FLOWERS. Many hermaphrodite flowers mature their sexes at the same time, and are therefore known as HOMOGAMOUS as opposed to dichogamous. Even in homogamous flowers, where self-pollination seems most natural, several contrivances and adaptations are met with which wholly prevent self-pollination, and help to bring about cross-pollination. Such homogamous flowers have been termed HERKOGAMOUS.

Fourth, DIMORPHIC FLOWERS. Amongst homogamous flowers there are several in which the floral adaptations are such that they favour cross-pollination without wholly excluding the chances of self-pollination. As a matter of fact, these flowers are usually cross-pollinated; but if cross-pollination fails they have recourse to self-pollination. A striking floral adaptation of this kind is HETEROSTYLY, a condition met with in some species of plants. These plants produce DIMORPHIC flowers, or flowers of two different forms (fig. 101). In one form the style is long and the stamens short, and in another form the

style is short and the stamens long; but the short styles and the short stamens, as well as the long styles and the long stamens, although they belong to different flowers, are of the same height respectively. In these flowers, pollination is usually most potent between styles and stamens of the same length, which necessarily belong to different flowers, and less potent or wholly impotent or even positively injurious between styles and stamens of unequal length. The pollination of the first kind has been described as

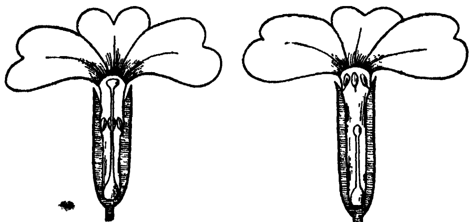


Fig. 101.—Dimorphic or Heterostylic Flower

LEGITIMATE, and of the second kind as ILLEGITIMATE. Similarly there are TRIMORPHIC flowers.

Fifth, CLEISTOGAMOUS FLOWERS. There are some homogamous flowers which never open, and have therefore no chance of getting foreign pollen. They are therefore necessarily self-pollinated. These are known as CLEISTOGAMOUS. There are also PSEUDO-CLEISTOGAMOUS flowers, which open for a short time and then close permanently. These are usually self-pollinated, though cross-pollination is not excluded.

Sixth. There are, however, many open homogamous flowers in which self-pollination usually takes place, though cross-pollination is not excluded.

The results of investigations on pollination may be summarized in the words of Hildebrand: "There are

no sexual plants which can constantly reproduce themselves by self-fertilization alone; cross-pollination is possible in all; in most cases self-fertilization is prevented by special adaptations, or is impossible, or at least not advantageous, while cross-fertilization alone can occur, does actually occur, or has good results". On the results of investigations by Darwin and others, Hermann Müller has formulated the following proposition: "Whenever progeny resulting from crossing comes into serious conflict with the offspring resulting from self-fertilization, the former is victorious. Only where there is no such struggle for existence can self-fertilization often prove satisfactory for many generations." Sprengel, who together with Kohlreuter may be regarded as the founder of the study of flower-pollination, has added the following remark about pollination: "As very many flowers are of separate sexes, and probably quite as many of the hermaphrodite ones are dichogamous, it seems that Nature is unwilling that any flower should be fertilized by its own pollen".

Examples may now be cited to illustrate the different groups of flowers referred to above. The nature of their pollination will be discussed in detail in another chapter.

First, unisexual flowers. **Shasha** or Cucumber, **tarmuz** or Water-melon, **belati-kumrha** or Gourd, in fact all plants belonging to the Natural Order *Cucurbitaceæ*; most plants of the Natural Order *Euphorbiaceæ*, such as **lal-bharenda**, **rerhi** or Castor-oil plant, **pituli** (*Trewia nudiflora*); most Palms, such as **tal**-palm, **khejur** or Date-palm; several *Graminaceæ*, such as **bhutta** or Indian Corn, are well known examples of plants with unisexual flowers. Gymnospermia as a class are all unisexual.

Second, dichogamous flowers. *Aristolochia indica* or **isher-mul, champa,** *Magnolia grandiflora* or **grand-champa, rangchita** (*Pedilanthus tithymaloides*, though, strictly speaking, unisexual), are good examples of protogynous flowers. Most of the *Malvaceæ*, such as **jaba, dhanrhas, shimool**; most of the *Umbelliferæ*, such as **dhania** or Coriander, **juan** or Ajowan; most *Geraniaceæ*, such as **amrul**; most *Compositæ*, such as **kukur-songa, suryamukhi** or Sun-flower; Pink, *Portulaca grandiflora* (common garden plants), **bakas** (*Adhatoda Vasica*) a wild shrub, common **kul**, are plants with protandrous flowers. Dichogamy is not confined to hermaphrodite flowers. All monœcious and most diœcious plants are, as a rule, protogynous. For example, in **pituli** the female plants flower earlier than the male plants.

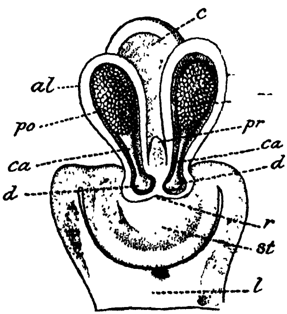


Fig. 102.--Section of Orchid Flower

l, Portion of labellum. *st*, Stigma. *r*, Rostellum. *po*, Pollinia. *a.l.*, Anther lobe. *ca*, Caudicle. *d*, Disk. *pr*, Prolongation of rostellum.

Third, herkogamous flowers. The floral adaptations in most *Orchidaceæ*, *Labiatæ*, *Scrophulariaceæ*, *Asclepiadaceæ*, and *Apocynaceæ* are such that self-pollination is wholly impossible. For instance, in most *Orchidaceæ* (fig. 102) the centre of the flower is occupied by a column (gynostemium), at the apex of which is situated the single anther with its pollen-grains usually bound together into two pollen-masses or POLLINIA. Each pollinium is provided with a short stalk or CAUDICLE, and the caudicle ends in a DISK. Immediately below the anther, on the anterior face of the gynostemium, is situated the concave viscid

stigma, overhung and wholly hidden from the anther by a projecting beak-like hood of it (stigma) known as ROSTELLUM, on the back of which are the two pollinia. The pollen-masses thus situated have absolutely no chance of reaching the stigma without external help. The situation of the anthers, at a lower level than the stigma as in many *Cruciferæ*, or of the stigma remote from the anthers as in some *Caryophyllaceæ*, or where the dehiscent face of the anthers is extrorse as in *Gloriosa superba* — these are also adaptations unfavourable to self-pollination. Other similar adaptations for preventing self-pollination will be treated of in another chapter.

Fourth. Dimorphic flowers are common in *Geraniaceæ*, as *Biophytum* (**lak-chana** or **ban-narenga**, and other plants of this genus); in *Linaceæ*, as *Erythroxylon lucidum*, *E. obtusifolium*, *Reinwardtia trigyna*, *Hugonia Mystax*; in *Rubiaceæ*, as *Adenosacme longifolia*, *Randia uliginosa*, *Chasalia curviflora*, *Knoxia corymbosa*; in *Boraginaceæ*, as *Macrotomia perennis*, *M. Benthami*; in most plants of the genus *Primula*; in some *Chenopodiaceæ*, as *Beta vulgaris*, and in some *Oleaceæ*, as **mallika, juin, kund,** *Jasminum*, &c.

Fifth, cleistogamous flowers. *Commelina benghalensis*, known in Bengali by the name of **dholapata** or **jata-kanshira**, bears cleistogamous flowers (fig. 103). The herb grows as a small weed in ditches and marshy ground, and flowers in the beginning of spring. It bears handsome small open blue flowers in the axils of the upper leaves, with some fertile and some barren stamens and a 2–3-celled ovary. But the plant also bears small inconspicuous closed flowers under the ground. The seeds of these latter flowers have been found to be highly potent, whereas the

seeds of the aerial open flowers are either wholly infertile or at any rate rarely fertile. *Arachis hypogæa*, known in Bengali as **chiner-badam** or **mat-kalai**, also bears cleistogamous flowers in addition to the ordinary bright-yellow open flowers. **Kantal**, the Jack-fruit tree of Bengal, is known to produce underground big Jack-fruits which ripen under the ground and bear fertile seeds. When the fruits are ripe the ground under which they lie opens and the characteristic smell of ripe fruits is emitted through the opening. Generally they lie so deep that they have to be dug out. The male and the female spikes on the aerial parts of the stem are well known, and it is also well known that the female spikes give rise to ordinary Jack-fruits. How the underground female spikes are pollinated is a mystery, but that they produce fruits with fertile seeds is a matter of common knowledge. PARTHENOGENESIS, or the production of fertile seeds without pollination and fertilization, is not unknown among plants, so that the fertile underground fruits may be an instance of parthenogenesis, or the result of occasional cleistogamous bisexual flowers. Such

Fig. 103.—Dholapata or Jata-kanshira (*Commelina benghalensis*)

o.f., Open flowers above ground. *c.f.*, Cleistogamous flowers underground.

bisexual flowers are occasionally met with among both male and female aerial spikes. In Malacca-jhangi (*Aldrovanda vesiculosa*), **lakchana** (*Biophytum sensitivum*, a common roadside herb), **alak-lata** (*Cuscuta*), and *Jasminum*, cleistogamy has been observed from time to time. Pseudo-cleistogamy has been observed in **amrul** (*Oxalis corniculata*), **barha-nunia-shag** (*Portulaca oleracea*), and *Drosera Burmanni.*

Sixth. Among open homogamous flowers (*Chasmogamy*) autogamy has been observed in *Portulaca oleracea* and *Mirabilis Jalapa* (**krishna-kali**), in which latter flower the filaments and the style roll together spirally, and thereby get so entangled that the pollen and the stigma come into contact. In Malacca-**jhangi** (*Aldrovanda vesiculosa*) the anthers get bound to the stigma by pollen-tubes. In **gandha-raj** the stigma rises to the mouth of the corolla-tube and is closely embraced by the mature anthers, which on dehiscence dust the receptive surface of the stigma with pollen-grains. In many *Cruciferæ* during flowering the filaments elongate, so that the anthers, which to begin with are at a lower level, finally reach the level of the stigma and pollinate it. In *Grewia asiatica* (**phalsa**) (see fig. 169) and some *Malvaceæ* the stigmas, which are at a higher level, either contract or bend so as to reach the level of the anthers and get pollinated. In *Opuntia* (**nag-phani**) and many *Compositæ* the filaments are from the first inwardly curved; later on, they curve still farther inwards, until the anthers come in contact with the stigma, or are perpendicularly above the stigma and able to shed the pollen upon it. The effect of autogamy is very varied. For instance, in some it is absolutely sterile, in some it is equally potent with

allogamy, while in others the effect of foreign pollen is more effective or prepotent.

CHAPTER XVI

FLOWERS IN RELATION TO POLLINATING AGENTS

For the purpose of crossing, the help of certain external agents is necessary. According to the nature of this agency flowers have been grouped into three principal groups, namely, (1) ANEMOPHILOUS or wind-flowers, (2) ENTOMOPHILOUS or insect-flowers, and (3) AQUAPHILOUS or water-flowers.

Anemophilous or wind-flowers have certain characters in common which distinguish them from insect-flowers. Thus wind-flowers are inconspicuous, or small and dull in colour, and wanting in nectar. They produce a much greater quantity of pollen-grains than the insect-flowers, as the pollen-grains run a great risk of being washed or blown away during their transit. Moreover, the pollen-grains of these flowers are smooth, light, dry, dust-like, and easily blown about. The stigmas are often of considerable size and branched (*Trewia*, Castor-oil) (see figs. 236, 237), or richly provided with feathery outgrowths (Grasses) (see figs. 271, 273), or drawn out into long threads (Maize)—which are special adaptations for catching wind-borne pollen. The anthers and stigmas are exposed to the air, and this exposure is often enhanced by the plants shedding their leaves at the time of flowering. The anthers are often exserted and versatile, or else the whole male inflor-

escence is in the form of an easily movable catkin or spike (Maize).

Wind-flowers are usually dichogamous or diclinous, so that self-pollination is out of the question. For example, all Gymnospermia, such as Pines, Firs, Cycads, &c., are diœcious or monœcious, and wind-pollinated. Their pollen-grains are often provided with wings or air-sacs, which serve to enhance their buoyancy and thus keep them drifting in the air for a longer time than would otherwise be the case. These floats and wings also serve as a steering-gear in the air. As pollen-grains are spoilt by moisture, they are produced and contained in these plants in the excavated dorsal surface of the staminal leaves (see fig. 279). Similar and various devices for the protection of the pollen are to be seen in flowers. Papaw (see figs. 77, 78) is a diœcious plant, with large white sessile female flowers, two or three in number, clustered in the axil of a leaf, and small white male flowers, innumerable in number, arranged in long pendulous spikes. The ovary is large, and the sessile radiating branched stigma protrudes out of the corolla-tube. The flowers possess the characters of wind-flowers, and are, in fact, pollinated by wind agency. **Pituli** (*Trewia nudiflora*) is a common diœcious tree possessing all the characters auxiliary to wind-flowers; it sheds its leaves at the time of flowering, so that the exposed long hairy stigmas have every possible chance of catching the drifting pollen-grains. The Grasses, with exserted stamens, versatile anthers, and branched feathery stigmas afford good examples of wind-flowers. Most *Juncaceæ* (Rushes or **shar**), Sedges, *Palmaceæ*, *Chenopodiaceæ*, and *Rumex* are familiar examples of wind-flowers. Many of our common fruit trees, such as Mango, **amrha**, Litchi,

jam, jamrul, deshi-badam (Country Almond), &c., are usually wind-pollinated, though insect-pollination is by no means uncommon.

In entomophilous or insect-flowers the pollen-grains are larger, more or less sticky, and their exterior is often studded with spines, knobs, or other projections which facilitate their adhesion to the body of an insect. At times the pollen-grains are bound together in masses by threads of a delicate sticky substance, so that their transport by wind is rendered impossible. Insect-flowers employ many means of attraction for enticing suitable insects to visit them, such as colour, odour, proffer of food in the form of pollen-grain or nectar or enclosed sap. It is the petals or perianth-leaves that, owing to their bright colour, play the leading part in making the flowers conspicuous to insect visitors. The coloration of the petals is often discriminative. Thus, if one side of a corolla is not visible to insects on the wing, it is less brightly coloured than the side which they are able to see. The perianth-leaves, which spread out like a star in the sunlight, are of a shining colour on their inner face, while on the outer or under surface they are either green or of a dull colour. In **shalook** (*Nymphæa alba*) (fig. 104), for instance, the inner face of the sepals visible to insects on the wing is coloured white, while the outer or under face, which lies upon the water and is therefore not visible from above, has a green colour. In urceolate and campanulate flowers the inner surface is less conspicuous than the outer

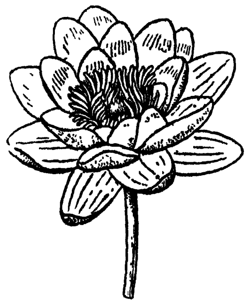


Fig. 104.—Flower of Shalook (*Nymphæa alba*)

surface, which is exposed to the view of insects as they fly about in quest of food. When the petals are modified, or not fully developed, or absent, the sepals often take over the function that properly belongs to the petals, as in *Holmskioldia sanguinea* and *Sterculia Roxburghii* (**ushli**) (see Plate V, B), — trees with a deep-red calyx. The petals are frequently helped by the sepals in the work of allurement, so that both the perianth whorls minister to the same end. It frequently happens that flowers which are by themselves inconspicuous are rendered conspicuous by coloured bracts, as in **bagan-bilas** (*Bougainvillea*), **lalpata** (*Euphorbia pulcherrima*), and *Houttuynia reflexa*. In *Mussænda* one of the sepals develops into a large white-coloured leaf. Small inconspicuous flowers are often made conspicuous by their association in an inflorescence. Thus the capitula of the *Compositæ* are visible from a great distance, so that they receive more insect visits than other plants. The ray florets are often ligulate, by which the end in view is attained more successfully. The enlargement of the marginal flowers of an inflorescence is often met with, as in the corymbs of many *Cruciferæ* and in the umbels of many *Umbelliferæ*. Similarly, the inner flowers of an inflorescence are often sexual and the outer ones asexual, the latter greatly developing their attractive parts at the expense of the stamens and pistil, as in many *Compositæ*, *Umbelliferæ*, and *Cruciferæ*; or the upper flowers may serve to attract while the lower flowers are concerned with reproduction. Occasionally the perianth leaves are dull-coloured and unattractive, and to compensate for this the stamens are modified into bright-coloured petaloid staminodia, as in most *Scitaminaceæ*; or the anthers are brightly coloured, as in Mignonette. Conspicu-

ousness is increased in many cases by the inflorescence developing flowers on one side only, as in Foxglove (*Digitalis Sp.*); or by colour-contrast, as in Pansy (*Viola tricolor*); or by flowers assuming a more intense hue after pollination, and thereby rendering the plant more conspicuous, as in **sthal-padma** (*Hibiscus mutabilis*) and species of *Fuchsia*; or by colour-contrast between the flower and the ground.

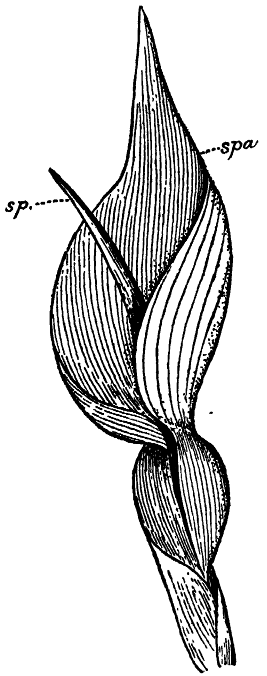


Fig. 105.—Ghekul or Ghet-kachu (*Typhonium trilobatum*)

sp, Spadix. *spa*, Spathe.

Next to colour, odour is the most important allurement for insects, and it is often difficult to decide which of the two is more effective. Odour usually comes from flowers, but in some plants, as in species of Mint, *Lavendula*, *Ruta*, Coriander, and *Citrus*, the smell of leaves and stems is an obvious attraction. Often colour and odour are mutually exclusive. Thus the conspicuously coloured flowers of **shial-kanta**, Poppy, *Azalea indica*, &c., are odourless; while the inconspicuous flowers of Mignonette, Vines, **hasna-hana**, &c., possess a strong odour. On the other hand, association of colour with odour is not wholly wanting, as in many Roses, Pinks, Magnolias. Odours agreeable to bees, butterflies, and hover-flies are also, as a rule, acceptable to man, while many odours which are pleasing to flies are disagreeable to human beings. Thus

carrion-flies and dung-flies take pleasure in odours that are disgusting to us. Certain flies are common everywhere in closets, and delight in disgusting substances. These flies prefer to visit flowers with odours or colours disgusting to us and to higher insects alike. Such flowers have therefore been called NAUSEOUS FLOWERS, as, for example, **ghekul** or **ghet-kachu**

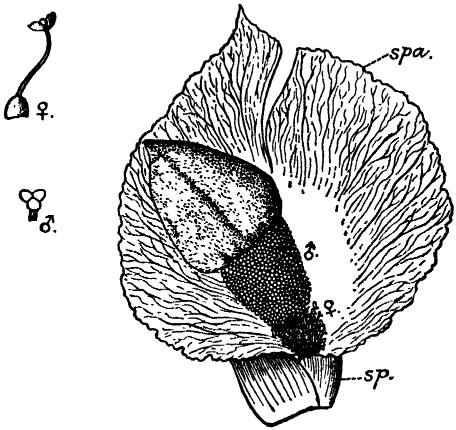


Fig. 106.—Ol (*Amorphophallus campanulatus*)

sp, Spadix. *spa*, Spathe.

(fig. 105), **ol** (fig. 106), which emit a strong fœtid odour during the night. Many flowers are scentless or nearly so during the day, and exhale a very strong odour during the night, as, for example, **sheuli, mallika, juin, rajani-gandha, hasna-hana.** The nauseous flowers mentioned above are also of this kind.

Insects that have been enticed by colour or odour, or both, are offered by the flowers pollen, and usually also nectar or honey, as food; and in return for this hospitality the visitors, as a rule, effect their pollination. Secretion of nectar or honey takes place in

parts of flowers by special glands called NECTARIES. From a fully exposed position, as in most *Umbelliferæ*, to a concealment inside a long corolla-tube, as in **taru-lata**, Datura, **karabi**, or in long spurs, as in *Orchidaceæ* and **dopati** (see fig. 79), there are numerous grades of concealment of the nectary; and insect visitors are determined by the position and character of the nectary. In order to render the finding of nectar more easy for insects that have been attracted to the flowers by colour or odour, the petals are often marked with coloured spots or lines or grooves called NECTAR GUIDES, which by their position and direction indicate the place where honey lies concealed. These nectar guides are naturally present in such flowers as are visited by insects during the day. They are wanting in moth-flowers that open during the night, when nectar guides would be of no use.

Visits of insects are facilitated in many flowers by the provision of a seat or alighting-platform. For instance, the wings and the keel of many *Leguminosæ*, and the lip or labellum of many *Labiatæ*, *Scrophulariaceæ*, *Acanthaceæ*, *Orchidaceæ*, and *Scitaminaceæ* provide such seats. The capitula of the *Compositæ* and the umbels of the *Umbelliferæ* are at the same time "chair and spread table". The alighting-places are always so situated that insects suitable for pollination touch either the anthers or the receptive stigma, while the access of unwelcome insects is prevented by varied contrivances.

Some flowers offer shelter to the visitors as well as pollen or nectar. During sudden showers nectar-seeking or pollen-collecting guests eagerly take refuge under the overhanging upper lip of *Labiatæ*, or in the campanulate flowers of *Convolvulus* and *Campanula*, which also afford shelter to visitors for the night when

they are overtaken by darkness while still at work. It is usually the smaller insects that seek shelter for the night in flowers and inflorescences.

A remarkable instance of relation between flowers and insects is found between *Ficus Carica* (fig. 107) and certain wasps. The jug-shaped inflorescence contains male flowers at the mouth and female flowers

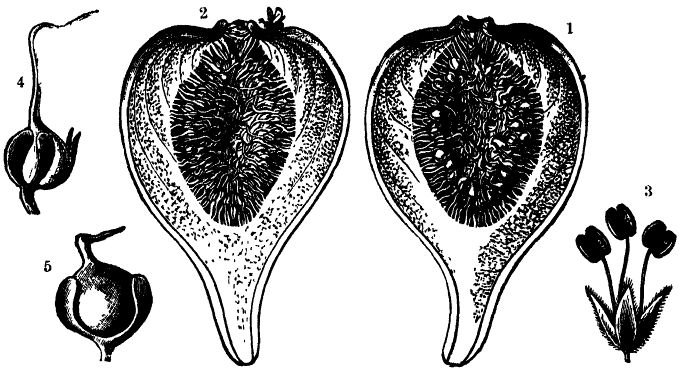


Fig. 107

1, Excavated capitulum of *Ficus Carica* full of gall-flowers produced by *Blastophaga*, cut through longitudinally; near the mouth of the cavity is a Fig-wasp (*Blastophaga grossorum*) which has escaped from one of the galls. 2, Do., full of female flowers, cut through longitudinally; near the mouth of the cavity are two Fig-wasps, one of which has already crept into the cavity whilst the second is about to do so. 3, Male-flower. 4, Long-styled female flower. 5, Gall produced from a short-styled gall-flower. 1, 2, Nat. size. 3, 4, × 5. 5, × 8.

deeper down. These latter are either long-styled or short-styled. The female wasp creeps through the mouth of the flask into the interior, and lays an egg near the nucellus of an ovule by sinking the ovipositor perpendicularly through the style-canal of a short-styled female flower. From the egg a larva develops, which feeds upon the surrounding tissue, and grows rapidly, filling the ovary and destroying the ovule. The ovary then becomes a GALL. The larva soon

passes through the pupa stage, and emerges out of the gall as a perfect insect by biting its way through it. The insect then makes its way through the mouth of the jug to the exterior, and, while creeping out, its body becomes dusted with the pollen-grains of the male flowers situated near the mouth. It then runs to another inflorescence, enters into it, pollinates the stigmas of the long-styled female flowers, and lays eggs into the short-styled female flowers known as GALL-FLOWERS. The wasps cannot lay their eggs in the cavity of the ovary of the long-styled flowers, as the styles are too long for their ovipositors to reach the cavity of the ovary. Hence no galls are formed in them as in the short-styled flowers, and fertile seeds are produced in abundance.

In tropical countries like India birds like crows and **mainas**, and other animals like squirrels and bats, are useful agents of pollination. These animals are found in numbers visiting the big red open flowers of **shimul**, the scarlet-red papilionaceous flowers of **palthe-madar** (*Erythrina indica*), the showy racemes of large red flowers of Gold Mohur, and the long pendulous spikes of bright-yellow flowers of **sondal** or Indian Laburnum. These plants blossom at the end of winter, and shed their leaves before flowering, so that the brightly-coloured flowers, freed from the interference of a mass of green foliage, become a very conspicuous feature of the scenery, and attract birds, &c., from a distance.

Well-known water-pollinated plants are comparatively few, and confined almost wholly to the aquatic family of *Hydrocharidaceæ*. A curious example of such plants is common in our tanks, and is known as **ganj** or **pata-shaola** (*Vallisneria spiralis*) (fig. 108). It is a diœcious plant, which lies rooted to the mud

and submerged, and bears long, ribbon-shaped clusters of radical leaves. The male flowers (A) are sessile, and situated low down amongst the radical leaves. The female flowers (B), on the other hand, are borne upon long stalks, which, remaining spirally coiled, keep the flowers under water. When the male flowers mature, they get detached from the plant and ascend to the surface of the water, on which they float freely,

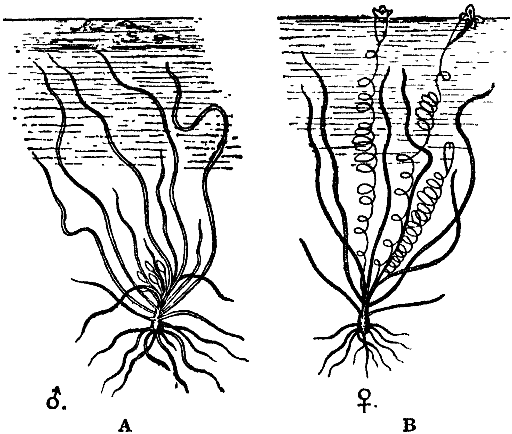


Fig. 108.--Pata-shaola (*Vallisneria spiralis*)

being swayed hither and thither by the wind. By a curious instinct the stalks of the female flowers are at the same time uncoiled, bringing the hitherto submerged female flowers to the surface. "After selecting their husbands, the female flowers sink to the bottom of the tank by (again) coiling up their long stalk." The fruits ripen under water and germinate in the mud. *Hydrilla verticillata* is another common submerged diœcious weed (a kind of **jhangi**) of our tanks. The short-pedicelled male flowers are solitary. At the time of pollination they separate from the plant and float

on the surface of the water. The sessile female flowers, one or two in number within a tubular spathe, have their ovary produced beyond the spathe into a filiform beak ending in three filiform fimbriate stigmas which float on the surface. The anthers of the floating male flowers open elastically, dusting the fimbriate stigmas of the female flowers that happen to be floating near them. *Lagarosiphon Roxburghii* (**rasna-jhangi**) is also a common submerged diœcious water-pollinated weed with the ovary, style, and stigma somewhat like those of *Hydrilla.*

CHAPTER XVII

ENTOMOPHILOUS FLOWERS

Entomophilous flowers may be grouped into nine classes, namely: (1) pollen flowers, (2) flowers with exposed nectar, (3) flowers with partially-concealed nectar, (4) flowers with completely-concealed nectar, (5) social flowers with concealed nectar, (6) bee-flowers, (7) butterfly- and moth-flowers, (8) pitfall flowers, and (9) pinch-trap flowers.

1. POLLEN FLOWERS.—These offer only pollen to their visitors and are all very simple and regular in form (actinomorphic), with abundant pollen freely exposed, as *Papaver* (Poppy), *Argemone* (**shial-kanta**) (fig. 109), *Magnolia* (a kind of **champa**), *Michelia* (**champa**), *Anona* (**ata**), *Solanum* (**begoon**, &c.), *Hypericum*, &c. The five chief floral colours—namely, white, yellow, red, violet, and blue—are represented in them. The visitors of white, yellow, and red pollen-flowers are chiefly bees and hover-flies with a

short tongue. Concealed honey is not accessible to these short-tongued insects, hence they eagerly visit pollen-flowers which yield a rich spoil of pollen. *Portulaca grandiflora* is a common season herb of our gardens, with red actinomorphic flowers, possessing abundant pollen. In younger flowers the style is erect and rises considerably above the stamens. When mature, it falls down and reclines upon the corolla. An insect visiting the flower naturally alights upon the outspread petals and walks down towards the stamens, which, being sensitive, fall upon the insect on being disturbed and dust it with pollen-grains. Should the insect next visit an older flower with the style reclining upon the petals, it would be sure to deposit the pollen of the first flower upon the radiating and recurved stigmas of the second, and thus bring about cross-pollination. The crossing of Poppy, **shial-kanta**, &c., is somewhat similarly effected.

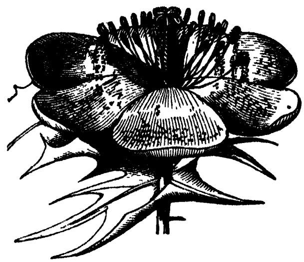


Fig. 109.—Flower of Shial-kanta (*Argemone Mexicana*) open in the sunshine. Pollen which has fallen from the anthers is resting upon the concave petals

2. Flowers with Exposed Nectar.—These are all simple, open, and for the most part regular flowers (actinomorphic), generally white, greenish-white, or yellow in colour. Short-tongued wasps and flies are their chief visitors. Honey-bees and butterflies, which are long-tongued, rarely visit them. Most *Umbelliferæ* and some *Euphorbiaceæ* are good examples of flowers of this class.

3. Flowers with Partially-concealed Nectar.—These are mostly actinomorphic, and not always

fully expanded. Only in bright sunshine do they open widely, while at other times they close up. White and yellow are predominant colours, but these colours are more intense than in Class 2. Insects with a tongue of medium length are common pollinating agents. The *Cruciferæ* family of plants offers many good instances of such flowers.

4. FLOWERS WITH COMPLETELY-CONCEALED NECTAR.—Although actinomorphic flowers predominate, very many of them are irregular or zygomorphic. Red, blue, and violet colours displace the white and yellow of the last two classes (2 and 3). Long-tongued insects are the chief pollinating agents. The honey-bee, for example, may almost everywhere be found sucking the honey. The advance in floral specialization in the flowers of this class is accompanied by a distinctly higher level of specialization in the insects that visit them. Several *Papilionaceæ*, *Orchidaceæ*, *Labiatæ*, and *Scrophulariaceæ* are illustrative examples.

5. SOCIAL FLOWERS WITH CONCEALED NECTAR.—In these flowers the nectar is concealed, as in Class 4, but the flowers are associated in heads, so that they are rendered very conspicuous. There is also the possibility of several flowers being simultaneously pollinated. The *Compositæ* fall into this class. The whites and yellows amongst them are visited by insects akin to those that visit flowers with partially-concealed nectar. These insects are almost always of the same colour as the flowers. The reds, blues, and violets, on the other hand, are visited by insects which are practically the same as for flowers with concealed nectar. These insects also are of the same colour. It seems, therefore, that highly-organized insects prefer red, blue, and violet colours, hence these colours are to be regarded as a higher stage of floral coloration.

6. Bee-flowers.—These are regularly pollinated by bees and wasps. Zygomorphic flowers predominate in this class, and the predominating colours are red, blue, and violet. In the most highly specialized types of this class, such as most *Orchidaceæ*, only a few species of bee can effect pollination. The structure of the flowers of Orchids, described in Chapter XV, shows clearly that the pollinia cannot possibly reach the stigma without the help of an external agent. That agent is a long-tongued bee, which, attracted by the gorgeously-coloured labellum, alights on it as on a platform, and, finding the opening (*sp*) to the nectar-holding spur too narrow for its entrance, sends its long tongue into the spur for the purpose of sucking honey (fig. 110). In this attempt its forehead comes into contact with the rostellum (*r*), which is thus either pushed back or breaks, and the pollinia (*po*) come out and stick to the bee's forehead by means of the sticky disks and stand upright (1) on it. By the time the bee visits the next flower, the upright caudicle bends forward (2) and brings the pollinia in such a position that they point towards and touch the receptive stigma (*st*) of the flower. Now the stigma, with its viscid secretion, grasps the pollen-masses in such a manner that either the whole pollen-mass or a portion of it adheres to the stigma. This wonderful mechanism of cross-pollination brings out prominently

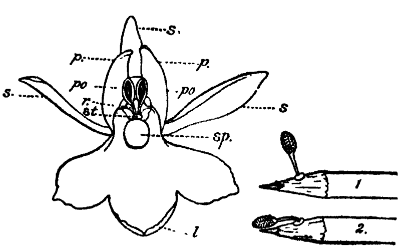


Fig. 110.—Flower of Orchis

l, Labellum. *sp*, Opening into the spur. *st*, Stigma. *r*, Rostellum. *po*, Pollinia. *s*, Sepal. *p*, Petal. 1, Pollinium as it first sticks to pencil head. 2, Same with caudicle bent later on.

the fact that even in homogamous flowers nature has made a provision for preventing self-pollination and securing cross-pollination. Most *Papilionaceæ*, *Violaceæ*, *Labiatæ*, and *Orchidaceæ* belong to this class. It is interesting to observe that flowers with a corolla-tube of horizontal attitude have always a large under lip, which is either brightly coloured or provided with nectar-guides. Such flowers are evidently elaborated for the visits of bees. Butterflies, as a rule, cannot rest upon the large under lip or platform, in consequence of their upright wings, whereas bees find a comfortable seat there. Small insects are usually prevented from entering by hairs surrounding the throat of the corolla-tube (fig. 111). In Goldfussia (*Strobilanthes*), a common garden annual, the bee alights upon the platform, and, directed by the nectar-guides, walks into the tube in quest of honey concealed deep down. Immediately on entering, the curved-up style (*a*) makes a *salaam* to the bee by straightening itself and then curving downwards (*b*). When busy sucking honey, the belly of the bee becomes coated with the pollen-grains, which she carries with her to the next flower and rubs the pollen-grains she has brought with her upon the curved-up style of the latter, which then, at the touch of the bee, straightens and curves down, as described above. This motion of the style prevents the bee from depositing the pollen of a flower upon the stigma of the same flower while she recedes and leaves the latter. The flowers of **bakas** (*Adhadota Vasica*) (fig. 112), with a bilabiate corolla, are vertical and often visited by butterflies, but, on account of an erect large upper

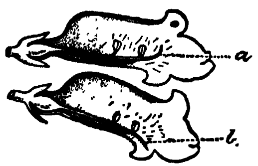


Fig. 111.—Goldfussia (*Strobilanthes*)

lip, are usually pollinated by bees. In consequence of a bend in the tube (*a*) the bee is prevented from going right down into the corolla-tube, as it does in Goldfussia. Thus forced to remain upon the platform, it uncoils its long proboscis and sends this down for honey. While thus exerting itself, it presses upon the bend, and thereby the lower lip is moved slightly downwards. This does not move the upper lip, stiffened as it is by three longitudinal folds along its back, but moves the stamens (*st*) from the upper lip and makes them come forcibly in contact with the back of the insect. The style (pistil), which is not yet mature, for the flowers are protandrous, is held firmly in a groove of the upper lip, but on ripening it leaves this groove and curves downwards into the tube of the corolla, and the stigma comes in contact with the pollen-covered back of a bee which had previously visited a younger flower with mature stamens. The lower lip is also marked with red bands and nectar-guides which unmistakably point to the honey-chamber.

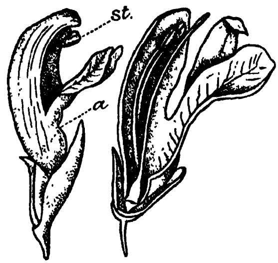


Fig. 112.—Bakas (*Adhatoda Vasua*)

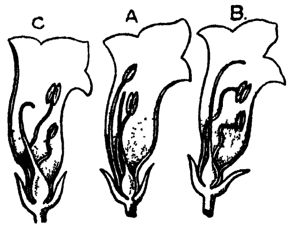


Fig. 113

Fig. 113 represents a flower closely allied to **bakas,** and also protandrous like the latter. C has a ripe pistil in the position of shorter stamens of A, and B has a ripe pistil in the position of the longer stamens

of A. Bees flying from flower to flower, some young and some old, must cross-pollinate them.

In *Pedilanthus tithymaloides* (**rang-chita**) the flowers are protogynous. The honey is secreted at the heel-like portion of the involucre. A bee alighting upon an older flower with ripe stamens (fig. 114, A), while busy sucking the honey, becomes coated with pollen. Should it next visit a younger flower with ripe pistil (fig. 114, B), pollination will be effected, for the ripe pistil of a younger flower occupies the exact position

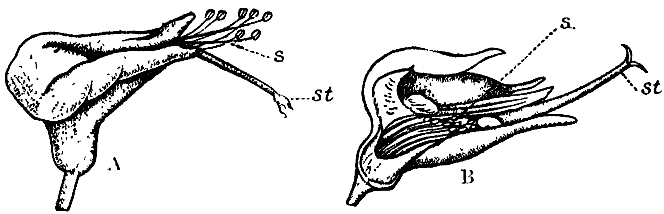


Fig. 114.—Rang-chita (*Pedilanthus tithymaloides*)

A, *s*, Ripe stamens; *st*, ripe drooping stigma (cyathium). B, *s*, Young stamens; *st*, ripe stigma.

of the ripe stamens of an older one. The flowers of this plant appear before the leaves, and they are conspicuous because of this and of their scarlet-red involucre.

7. BUTTERFLY- AND MOTH-FLOWERS.—In these the nectar is concealed in deep narrow tubes or spurs. The butterfly-flowers are usually red, moth-flowers are white. The more deeply the honey is concealed the more exclusively is it secured by butterflies. Many butterfly-flowers are distinguished by an agreeable and often very powerful odour. Moth-flowers, as stated above, are white and devoid of nectar-guides, and possess an odour that is frequently very powerful, and capable of being perceived from a great

distance by the moths that visit them. The strong aromatic odour of moth-flowers becomes specially noticeable towards evening, while during the day it may be wholly or partially wanting. Moth-flowers open exclusively, or at any rate chiefly, after dark. Butterfly-flowers with deeply-concealed nectar within a long corolla-tube are invariably vertical, as **rangan** and **nishinde** (*Vitex negundo*). In **nishinde** (fig. 115) the flowers are vertical, with a large odd petal of horizontal attitude (*a*) forming a platform for butterflies to alight upon, which carry the pollen-grains of one flower to the stigma of another flower, and thus cross-pollinate them. *Jasminum* (**juin, bela**), **rajanigandha, sheuli**, and **hasnahana** are moth-flowers which open at nightfall or at the approach of night, and then emit a strong aromatic odour. These flowers are all white, with spreading corolla-limbs and long corolla-tubes with deeply concealed nectar. In *Jasminum* the style is longer than the filaments, with a knee-like bend in the middle. The stigma lies at the mouth of the tube, while the anthers lie included within the tube. Further, the thick stigma, while mature, curves towards the corolla and comes in contact with it when the style is touched at the bend,—an evident arrangement for crossing. Nauseous flowers, mentioned in the last chapter, usually open in the evening, like moth-flowers, and are visited by carrion-flies and other night-roving insects. Some of these flowers have pitfall arrangements, as **ghetkachu, ol**, and **kachu**.

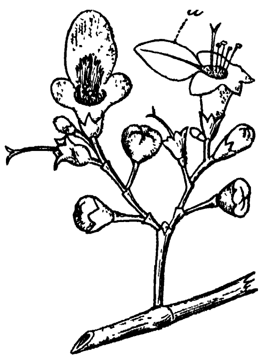


Fig. 115. Nishinde or Inchu
(*Vitex negundo*)

8. Pitfall Flowers.—These flowers form, as it were, a trap or pit, in which insect visitors are imprisoned for a period and then set free after pollination has been secured. In **isher-mul** (fig. 116) and allied species the simple perianth (*p*) is inflated below in the form of a jug (*t*), and contracted above into a narrow mouth with the single limb long, dilated, and oblique; the flowers are distinctly protogynous. The inner surface of the limb and the mouth of the jug-shaped perianth or trap are beset with oblique downwardly-directed hairs, which allow small flies or midges which visit them to glide easily into the inflated perianth, enclosing the anthers and stigmas at its bottom. If the flower happens to be a young one, the stigmas (*st*) are mature but not the anthers (*a*), and the insects (*i*) are kept imprisoned till the anthers mature, dehisce, and shed their pollen-grains. The pollen-covered insects then easily glide out of their prison, as the hairs which had hitherto prevented their egress dry up and make their escape easy. If the pollen-covered insects happen next to visit a young flower, the pollen-grains which they carry pollinate the receptive stigma of the latter. The plant, however, is not satisfied with merely having its own stigma pollinated: it keeps the insects imprisoned till its stigmas dry up and anthers mature and dehisce, so that the insects on their escape may carry the pollinating powder to other flowers. The

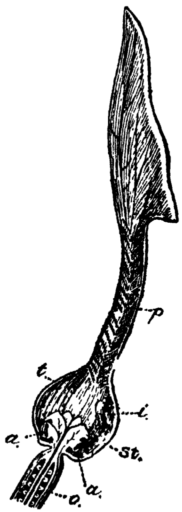


Fig. 116.—Isher-mul (*Aristolochia indica*)

o, Ovary. *a*, Anther. *st*, Stigma. *t*, Trap. *i*, Insect. *p*, Perianth.

insects forget their temporary incarceration because of the feed of honey which they get at the bottom of the perianth cavity. Moreover, when the stamens have passed maturity a kind of lid falls over the mouth of the perianth-tube, which discourages insects from entering it. There is then no honey to allure insects, nor pollen-grains for them to carry to other flowers. Several species of *Arum* and other species of the *Araceæ* family have a similar pitfall arrangement, not in their perianth, but in their spathe, and they are also protogynous, like *Aristolochia*. The flowers of **neem** have a sort of pitfall arrangement. They are protandrous with a sweet aroma. The filaments form a hollow column or tube with ten imbricated limbs, and at the mouth of the tube stand ten anthers at a higher level than the included stigma. The tube is lined internally with hairs pointing downwards. Small flies or midges are found within the flowers, and they are the pollinating agents. But the protandrous condition is so slight, and the flowers so dull-coloured, that self-pollination is also possible, and does take place.

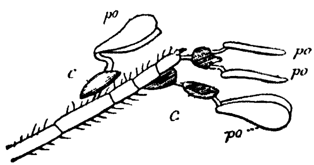


Fig. 117.—Pollinia (*po*) of Asclepias curassavica attached to the leg of a Butterfly by clips (*c*) (after Knuth)

9. Pinch-trap Flowers.—These flowers are provided with peculiar clips, to each of which two pollinia are attached. The clips grasp the proboscis, claws, or bristles of insect-visitors firmly, and are forcibly torn away by the insects when they feel themselves held fast (fig. 117). The insects, with the pollinia thus fastened to their body, thrust them into the stigmatic cavity unknowingly and unintentionally. Several *Asclepia-*

daceæ and *Orchidaceæ* plants have pinch-trap flowers. For example, *Asclepias curassavica* (fig. 118), an erect herb of waste places, with handsome orange-red flowers, is a typical example of this condition.

Of all pollinating insects the bee and the butterfly are more highly specialized than the rest, and the flowers for which they have special preference are likewise highly specialized. Moreover, these insects show distinct colour preferences. For instance, glaring colours, especially bright-yellow, are least agreeable to the honey-bee, while saturated blue is most attractive to it. A series has been constructed in which colours which are appreciated by bees have been placed in the order of their preference, namely, saturated blue, violet, blue, red, white, and pale-yellow, pure green, glaring red, and yellow. Similarly, butterflies markedly prefer dark colours to bright ones. It has already been mentioned that certain butterflies prefer flowers resembling their own wings in colour.

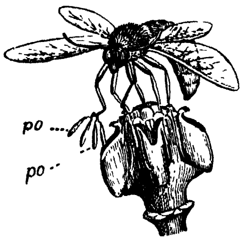


Fig. 118.- Asclepias curassavica, after removal of calyx and corolla

po, two pairs of pollinia catching the leg by clips (after Knuth)

CHAPTER XVIII

STRUCTURE OF POLLEN-GRAINS AND OF OVULES—FERTILIZATION AND FORMATION OF SEEDS.

Pollination is followed by fertilization, which consists in the union and complete fusion of the male cell with the female cell. The male cell is the POLLEN-

GRAIN, produced within the anther, and the female cell is the OOSPHERE or OVUM, produced within the ovule. This leads us to look into the structure of the ovule and of the pollen-grain.

In Chapter XIV the structure of the ovule has been described so far as the formation of the embryo-sac. The nucleus of the embryo-sac divides first into two parts; next, each of the latter divides into two parts, giving rise to four nuclei; and, lastly, each of these

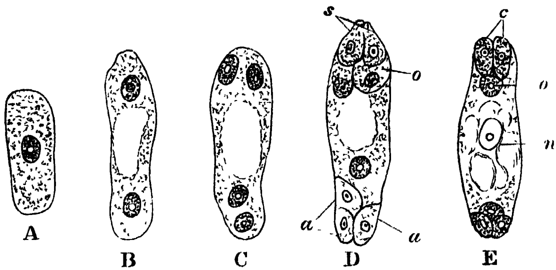


Fig. 119.—Successive Changes in the Embryo-sac of Polygonum prior to Fertilization

s, Synergidæ. o, Oosphere a, Antipodal cells. n, Secondary nucleus (after Strasburger)

four divides into two; so ultimately eight nuclei are formed. Three of them migrate to the micropylar end of the embryo-sac, forming what is known as the EGG APPARATUS, three to the opposite or antipodal end, forming the ANTIPODAL cells, and the remaining two fuse together, forming the SECONDARY nucleus of the embryo-sac, which usually remains near the centre of the embryo-sac (fig. 119). The nuclei at both the ends gradually form naked cells. Two cells of the egg apparatus are similar, and known as the guiding cells or SYNERGIDÆ, and the third, which projects into the cavity of the embryo-sac, is the female cell or oosphere. Usually the centre of the embryo-sac

is occupied by a vacuole. The ovule is now ready for fertilization.

A pollen-grain is a single cell with a cell wall in which may be distinguished a thick cutinized outer layer and a thin inner layer of cellulose. On the outer layer are thin or weak spots for the exit of the pollen-tubes. The protoplasmic contents, formerly called FOVILLA, are unusually rich in starch or oil, or both, and often contain chloroplasts. Before the pollen-grains are shed the nucleus divides first into two, one of which forms the naked VEGETATIVE CELL, and the other again divides into two, which form two naked cells known as GENERATIVE CELLS. The pollen-grain falling on the stigma and feeding on the sugary juice secreted by it, germinates; in other words, the inner cellulose layer protrudes through the weak spots of the outer cutinized layer, forming what is known as the POLLEN-TUBE. The pollen-tube carries with it the greater portion of the contents of the pollen-grain, including the vegetative and generative cells. The pollen-tube, making its way through the loose tissue of the style, enters into the cavity of the ovary, and, guided by grooves, lines, marks, or hairs within it, reaches the mycropyle of the ovule (fig. 120). The

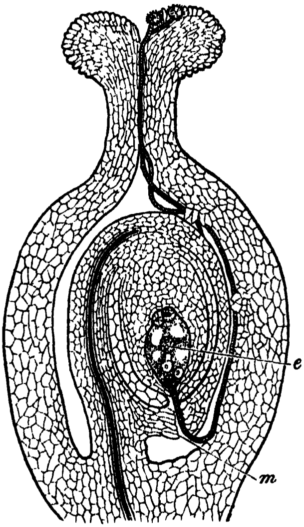


Fig. 120.—Longitudinal Section of a Pistil, with a Single Basal and Anatropous Ovule, showing the course of the Pollen Tube

m, micropyle; *e*, embryo-sac.

tube then enters into the embryo-sac and emits one of the generative cells, the other generating cell and the vegetative cell having been disorganized in the meantime. The generative cell, guided by the synergidæ, comes into contact with the oosphere and completely fuses with it, nucleus with nucleus, and protoplasm with protoplasm, giving rise to a single cell known as OOSPORE. This process of the formation of the oospore by the union of the male and the female element is known as FERTILIZATION. After fertilization the oospore secretes a cellulose wall, and is now a complete cell. The oospore then begins to grow, and gives rise to the embryo, with its radicle, plumule, and cotyledons; the number of cotyledons being one in Monocotyledons and two in Dicotyledons. The radicle always points towards the micropyle. In addition, the embryo is always provided with a process known as embryo-feeder or SUSPENSOR. While the embryo is developing, the embryo-sac is filled with a mass of cells or tissue, first by cell-division and subsequently by free-cell formation. This tissue is known as ENDOSPERM (fig. 121). The cells of the endosperm become the storehouse of food-materials, such as starch, oils, proteids, &c. The cells of the nucellus also become filled with similar substances, and the nucellus is now

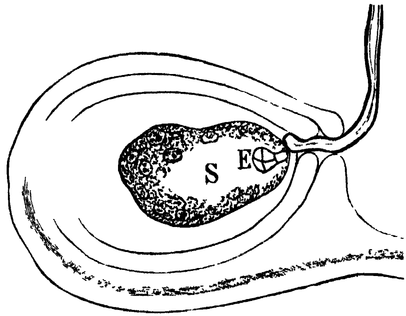


Fig. 121.—Ovule after Fertilization

S, Embryo-sac with developing endosperm.
E, Embryo (after Prantl and Vines).

distinguished as PERISPERM. Seeds with both endosperm and perisperm are comparatively few. Usually the endosperm grows at the expense of the nucellus and ultimately obliterates it. Such seeds are said to be ALBUMINOUS, or with endosperm. This is common among Monocotyledons. In the majority of Dicotyledons, however, the embryo develops at the expense of the endosperm, so that the whole of the endosperm formed at the outset becomes ultimately obliterated, and the seed becomes EXALBUMINOUS, or without endosperm. The integuments of the ovule also share in these changes. The two coats become fused together, and change more or less in texture and colour, forming what is known as the TESTA (fig. 122, *s*). Further, in some seeds the cells of the outer layer of the testa grow to form hairs, either all over the testa or on a particular part of it. For instance, in Cotton and Silk-cotton tree the seeds become covered all over with hairs which are known as cotton fibres; in **akanda** (*Calotropis gigantea*) (fig. 123), **karabi** (*Nerium odorum*), in fact in most *Asclepiadaceæ* and *Apocynaceæ*, the seeds are crowned with a tassel or COMA of hairs. In some seeds a new coat

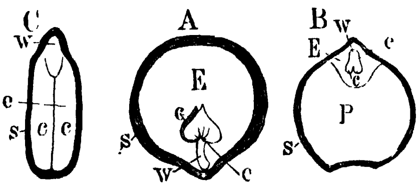


Fig. 122. Sections of Seeds

A with endosperm E. B with endosperm E and perisperm P. C, Exalbuminous seed. *s*, Testa; *e*, embryo; *c*, cotyledons; *w*, radicle.

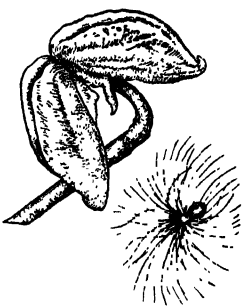


Fig. 123.—Akanda (*Calotropis gigantea*)

is formed either wholly or partially covering the testa. This coat is known as the ARIL. In **litchi** and **ansphal** or Bastard Litchi, the edible portion wholly covering the seeds is the aril. Mace or **jaitri** is the partial aril of the seeds of **jayphal** or Nutmeg (fig. 124, 2). The

Fig. 124.—1, Nutmeg Plant or Jayphal (*Myristica fragrans*). 2, Fruit, showing seed with mace (jaitri). 3, Section of seed.

white cushion at one end of Castor-oil seeds (see fig. 7), the heart-shaped white patch on the seeds of **shib-jhul** (*Cardiospermum Halicacabum*), are instances of partial aril. The minute seeds of **shalook** also are covered with an aril.

The structure of the ovule, and of the seed formed from it after fertilization, as described above, applies to Angiospermia. Gymnospermic ovules and seeds

differ in their structure from those of the Angiospermia in certain respects. Externally, the ovules have usually one integument; internally, the embryo-sac is formed deeper down in the nucellus, and within the embryo-sac is developed, before fertilization, a mass of tissue or endosperm filling up the embryo-sac. At the micropylar end of the endosperm are developed one or more ARCHEGONIA (fig. 125), each of which has a short neck and a ventral portion which encloses a nucleus. The ventral portion with the embedded nucleus is the female cell or oosphere. The pollen-grain falls directly on the micropyle of the ovule, and sends a pollen-tube, which makes its way through the nucellus and the neck of the archegonia. One of the generative cells of the pollen-tube fertilizes the oosphere, which then changes into an oospore. This oospore develops into an embryo, as in Angiospermia. It should be noted that the endosperm in Gymnospermia is formed before fertilization, and not after fertilization, as in Angiospermia. It should be further noted that the development of archegonia is wanting in Angiospermia. Another peculiarity of some of the Gymnospermia also requires special mention. In *Cycas revoluta* and a few other species of *Cycads*, as well as in *Ginkgo biloba*, the gen-

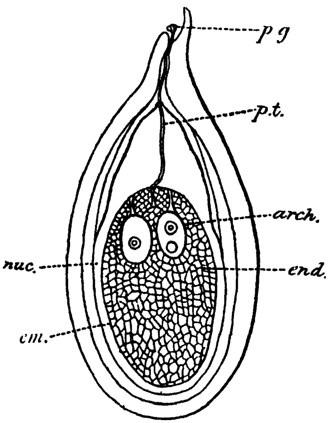


Fig. 125 - Macrosporangium (ovule) of Pinus at Maturity (after Green)

p.g., Pollen grain. *p.t.*, Pollen tube, *nuc.*, Nucellus. *em.*, Embryo-sac. *arch.*, Archegonia. *end.*, Endosperm.

erative cells develop into coiled many-ciliated SPERMATOZOIDS. The development of the endosperm before fertilization, the formation of archegonia, and the conversion of passive generative cells into motile spermatozoids have a very important bearing in the developmental and genetic relation between the Gymnospermia and the higher Cryptogamia, which will be treated of in the part of this book devoted to the description of Cryptogamia.

CHAPTER XIX

METHODS OF REPRODUCTION

Reproduction means the production of new plants out of pre-existing ones. The methods of reproduction may be divided into three kinds, namely, (1) VEGETATIVE, (2) SEXUAL, (3) ASEXUAL.

Vegetative reproduction consists in the production of new plants out of the vegetative parts of pre-existing plants. Forexample, plants like Plantain, Bamboo, Turmeric, Ginger, **kachu**, **ol**, Onion, Garlic, **rajani-gandha**, Potato, propagate themselves from their rhizomes, bulbs, tubers, and corms. Plants like **durba**, **thulkuri**, **shushuni**, **amrul**, propagate by runners and stolons. Plants like Sweet-potato, **shank-aloo**, **sata-moolee**, propagate by their tuberous roots. Propagation by leaves is not rare, as in **pathar-kucha** (fig. 126), **himsagar**, *Begonia*. In

Fig. 126.—Pathar-kucha (*Bryophyllum calycinum*)

plants like *Globa bulbifera* (see fig. 23) and other species of *Globa*, **rasun**, **murga**, *Agave Cantula* (see fig. 22), *Furcræa gigantea*, aerial bulbils separate from the inflorescence, fall to the ground, and give rise to new plants. Several species of *Dioscorea* (**chupri-aloo**) (see fig. 24) produce little tubers, or corm-like bodies, on their climbing stems, which, separating from the stems, fall to the ground, and give rise to new plants. The principle of vegetative reproduction has been imitated in gardening and farming. Thus propagation of plants by CUTTING, LAYERING, BUDDING, GRAFTING, &c., is nothing more than artificial imitation of nature.

Sexual reproduction, as already explained, consists in the production of new plants from seeds which are the results of the union of two sexual cells, male and female. In Phanerogamia and the higher Cryptogamia, where the sexual cells are differentiated, the process of their union is known as FERTILIZATION. In many lower Cryptogamia the sexual cells are not differentiated, and the union of these undifferentiated sexual cells is known as CONJUGATION. The product of fertilization is known as OOSPORE, and that of conjugation as ZYGOSPORE. The Oospore and Zygospore are both known by the name of ZYOTE. In rare cases the female cell or oosphere alone, without fusion with the male cell, develops into an embryo. This is known as PARTHENOGENESIS.

Asexual reproduction is a means of propagation by single cells, which are specially formed for the purpose, and known by the name of SPORES. As this method of reproduction is confined to Cryptogamia, readers are referred to a detailed description of it in the part devoted to Cryptogamia. Asexual reproduction is really a variety of vegetative reproduction,

with this difference, that in the former the reproductive body is a single cell, while in the latter it is usually multicellular.

In many plants, such as Plantain, Onion, Garlic, Potato, Sweet-potato, **shank-aloo**, and Sugar-cane, vegetative reproduction seems to be quite sufficient to secure the necessary multiplication of the species. In fact, some of them hardly ever produce fertile seeds, or, even if they do, are rarely propagated from them. In most plants, however, sexual reproduction is the rule, and the vegetative method of propagation is hardly ever resorted to.

Now the question that naturally arises is, Why are there so many methods of reproduction while one method perhaps would have been quite sufficient? Moreover, the sexual method is a far more complicated process than the other two methods. The sexual method, therefore, is evidently meant to subserve a purpose which the others fail to effect. In this method the properties of both the parents are combined and transmitted to the progeny, whereas the vegetatively produced offspring is identical in properties with the single parent which gives birth to it. The sexually produced offspring can never be identical in properties either with the male parent or the female parent, but possesses properties of both. This blending of properties is of immense value in the preservation of the species, inasmuch as, under changed conditions, the sexually produced offspring, which has inherited the properties of both the parents, has far greater capacity to adapt itself to changed conditions of life, and to survive in the struggle for existence, than the vegetatively produced offspring with its necessarily lesser power of adaptation and lesser chance of surviving in the struggle for life. The sexual method

of propagation, therefore, exercises a most dominating influence in the preservation of the species, while the other methods merely act as its helpmates.

In cultivated plants, where the object is to maintain the characters of the varieties and races unaltered, the vegetative method of reproduction is resorted to by preference, because these characters cannot come out true by seeds—that is, by the sexual method. For example, good varieties of Mango are always propagated by the vegetative method of grafting, as they seldom come out true if grown from seeds. On the other hand, if it is intended to produce newer or better varieties or races of cultivated plants, the sexual method of crossing is always resorted to. This also bears out prominently the dominating nature of the sexual method.

We have seen how freely the flowers of a species cross-pollinate one another. But cross-pollination between different but allied species is not unknown. Such a process of cross-pollination is known as HYBRIDIZATION, and the products of such crossings as HYBRIDS. The hybrids usually combine the characters of both the species, but seldom are the crosses between the hybrids fertile. They are, however, fertile if crossed with the parent species.

CHAPTER XX

DISPERSION OF SEEDS

If the seeds of a plant fall immediately below it, the ground on which they fall is necessarily restricted, and if it be unfavourable for germination, the seeds

may all die, and the plant fail to leave offspring behind. On the other hand, if the ground be favourable, so many plants may spring up within the restricted area that a hard struggle for life ensues amongst them, which may end in their total extermination. To provide against these and other contingencies, seeds and fruits (enclosing seeds) are found provided with varied devices for their dispersion, so that, on falling on varied areas with varied conditions, some are sure to come across favourable conditions of germination and growth, and produce healthy offspring, while others, meeting with unfavourable conditions, may not germinate at all, or, if they do germinate, produce only weaklings, which soon succumb in the struggle for existence.

The agents for the dispersion of seeds are nearly the same as those for the pollination of flowers. Thus they are dispersed by currents of air and water; by the forcible discharge from fruits which split elastically; by railroads and ships; and by animals, including man.

For the purpose of dispersion through air, seeds must remain floating in the air for some time, so that the currents of air may take them to distant places before they fall to the ground. In order to remain so floating they must be very small and light, and are often provided with hairs or similar appendages. For example, the seeds of **kapas-tula** or Cotton, and **shimool-tula** or Silk-cotton, are covered with hairs which are outgrowths of the testa; the seeds like those of **karabi** and **akanda** (see fig. 123), in fact the seeds of most *Apocynaceæ* and *Asclepiadaceæ*, are provided with a crown of hair (coma); the seed-like fruits of *Compositæ* (see fig. 81) are provided with a crown of hairy growths (the pappus) or teeth; the seed-like fruits

of Clematis (see fig. 144, *a*) and **chhagalbati** (*Naravelia zeylanica*) are tipped with long hairy persistent styles; the seed-like fruits of **kashe** (*Sorghum*) have abundant silky hair. Similarly, the seeds of many *Bignoniaceæ*, such as **atkapali** (*Stereospermum chelonoides*) and **parul** (*S. suaveolens*); of several *Sterculiaceæ*, such as **jungli-badam** (*Sterculia fœtida*), **kanak-champa** or **mooch-kunda**; of the Indian Cork tree; of **toon** (*Cedrela Toona*), Indian Satin-wood (*Chloroxylon Swietenia*), **sajina** (*Moringa pterygosperma*), have their testa prolonged into expanded wings; the fruits of **madhabi-lata** and **chuprhi-aloo** have similarly their pericarp expanded into wings; and the fruits of many *Dipterocarpaceæ*, such as **sal** (see fig. 165) and **garjan**, are provided with winged persistent sepals. These wings and hairy growths also serve as steering-gear while the seeds and fruits remain floating in the air. Wind-disseminated seeds are usually produced in large quantities, which is a provision against inevitable loss during transport.

Seeds and fruits that are dispersed by water—such as rivers, ocean-currents, &c.—are provided with thick water-tight coats, which prevent the water reaching the inside and spoiling their germinating power. They are lightened and made capable of floating by air enclosed in air-spaces within their coats. Thus fruits like Cocoa-nut, Betel-nut, Country Almond, and **gol-pata** (*Nipa fruticans*) have thick, spongy, air-tight coats, and the seeds of many aquatic plants have air-spaces in their covering, as in *Monochoria*, *Alisma*, *Butomopsis*, *Sagittaria*, *Nymphæa*, &c. Trees and shrubs with littoral habitat bear fruits or seeds, which remain floating in the water for a considerable time without their germinating power being impaired in any way. The appearance of Cocoa-nut palms as the first

vegetation on isolated coral islands of the Laccadives and Maldives is due to the possession of such devices in the coats as have been described above. The first vegetation that covers the face of islands newly raising their heads above the surface of the ocean is no doubt due to wind- and water-transported seeds of flowering plants and spores of flowerless ones.

Many fruits burst with a sudden jerk or explosion, so as to scatter the seeds to a great distance. **Dopati** (see fig. 79), **amrul**, **bharenda** or Castor-oil, and **sheuli** are very common instances. How the capsules of **dopati** burst and the valves recoil and twist spirally, scattering the seeds, is a very familiar example. In most of the large-flowered Geraniums the beaks of the fruit in coiling contract with such suddenness that the cocci, with enclosed seeds, are shot out of the fruits, which rupture septicidally (fig. 127). Similarly, in many *Acanthaceæ*, such as *Rungia parviflora*, *Dicliptera Roxburghiana*, and *Phaylopsis parviflora*, while the capsules dehisce the placentas separate elastically from the valves to scatter the seeds.

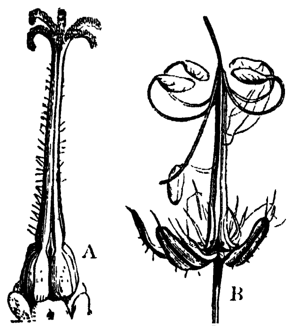


Fig. 127.—A, Pistil, and B, fruit of *Geranium*

For the purpose of dissemination through the agency of animals, various devices are met with in fruits and seeds. Many seeds and fruits are provided with hooks, burs, or rough or sticky coats, by which they attach themselves to animals and are transported from place to place, as the hooked fruits of **bag-nakha** (*Martynia diandra*) (fig. 128), the rough fruits

of **apang**, the burred fruits of **chor-kanta** or **bhant**, and the hooked fruits of **ban-okra** (*Urena lobata*). The undigested seeds, especially those of Grasses on which grazing cattle feed, pass out with the excrements with the germinating power unimpaired, and are thus distributed. Animals like jackals and bears, which feed upon such fruits as **kul**, **khejur**, **kantal**, &c., distribute their seeds in the same way as the cattle. Parrots and parakeets bite off the ears of many grasses and carry them to great distances.

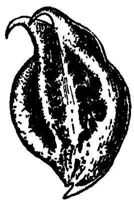


Fig. 128.—Bag-nakha (*Martynia diandra*)

Field rats, by their habit of carrying and burying seeds and fruits, promote dissemination. Under many trees on which bats are seen clinging in large numbers during the day, Country Almond, **supari**, and other fruits are found in abundance in the morning, no doubt carried by the bats during their night excursions. Fruits like those of **champa** on dehiscing expose curious-looking red seeds, suspended from them like so many Chinese lanterns. These seeds attract from a great distance birds which remove them from the fruits and leave them on the branches of trees on which they wipe their beaks. The succulence and agreeable taste of many fruits also promote their dispersal, the fruits being eaten by animals, and the seeds either rejected by them or passing through their alimentary canal without being injured, as **am**, **jam**, **khejur**, **kantal**, **phuti**, **tarmuz**, Guava, Papaw, **bael**, &c. The red-coloured fruits of **bot** and **aswathwa** attract crows and **mainas** from great distances, which regularly feed upon them, and wherever their droppings fall, there these trees spring up. This accounts for the curious situations in which they are found, such as the roofs and cornices of

Eichornia crassipes (Water Hyacinth)

pucca buildings and the tops of trees like Palms. Ruins of temples and palatial buildings completely destroyed by their growth are common sights in villages and towns which were once very flourishing. The seeds in passing through the stomach of these birds have their germinating power improved instead of being impaired. In fact, the seeds which have not passed through the alimentary canal of the birds are difficult to germinate. Birds like heron, snipe, &c., which frequent marshy places, carry with the mud enclosed in their claws seeds of marsh plants, and transport them from place to place. This accounts for the rapid dispersion within the last few years of *Eichornia crassipes* (Plate III)—which, however, are also largely propagated by resting buds and runners —over the shallow tanks, pools, and marshes of Calcutta and its neighbourhood. Rail-roads and boats are no less important transporting and disseminating agents. A few well-known examples of plants which have been introduced in this country from America and other foreign countries through the agency of man may fittingly close this chapter; such as Cinchona, **anaras** or Pine-apple, Papaw, Potato, Tobacco, **bhutta** or Maize, **ata**, **ghritakumari**, **natkan** or Anatto, and **lanka** or Cayenne pepper. It will interest readers to learn that **pathar-kucha**, which is now so common all over Bengal, was first introduced by Lady Canning in the gardens of the Government House, Calcutta (Dr. W. H. Gregg's *Textbook of Indian Botany*).

CHAPTER XXI

FRUITS AND SEEDS

We have learnt that seeds are produced from ovules as the result of fertilization. Fertilization also gives an impetus to the growth of the ovary, which then matures and forms what is known as fruit. If fertilization fails, the ovary, as a rule, does not develop into a fruit, but withers and falls away along with the other parts of the flower. There are, however, some exceptions, met with mostly in cultivated plants, such as Plantain, Orange, Guava, Papaw, &c., in which the ovary matures into fruit even without previous fertilization. This has been the result of a long process of cultivation and selection.

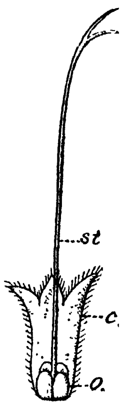


Fig. 129.—*o*, 4-lobed ovary. *st*, Gynobasic style. *c*, Calyx.

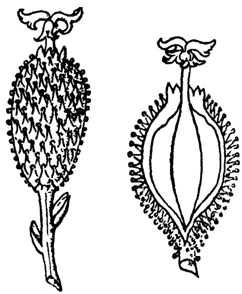


Fig. 130.—Ovary enclosed within persistent Base of the Perianth

Bagh-anchrha ♀ (*Pisonia aculeata*)

A fruit may therefore be defined as a mature ovary. In some cases the calyx persists, forming a more or less complete covering of the fruit. Thus in the *Labiatæ* or **tulsi** family of plants the dry calyx persists in the form of an open cup enclosing the 4-lobed small fruit at its bottom (fig. 129). In other cases, as **chalta, sal, sagoon, begoon, tepari** (*Physalis peruviana*), **krishna-kali, punar-naba** (see fig. 223, *p*),

and **bagh-anchrha** (fig. 130) the calyx or perianth is accrescent, that is, not only persists but grows along with the fruit and forms parts of it. In **chalta** the accrescent 5-parted calyx completely encloses the true fruit, and is the part of the fruit that is edible. In **hijli-badam** or Cashew-nut (*Anacardium occidentale*) (fig. 131) the fleshy peduncle is a part of the fruit on the top of which grows the kidney-shaped nut; both the peduncle and the kernel of the nut are edible. The fruit (see fig. 176) of **bhala** or Marking Nut (*Semecarpus Anacardium*) is similar, but the nut is roundish. In Guava and Apple (fig. 132) the fleshy enveloping thalamus, the so-called calyx-tube, grows along with and forms part of the fruit, and this is the edible portion of the fruit. In the HIP (fig. 133) or fruit of the Rose the so-called

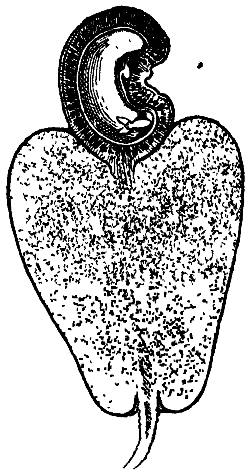


Fig. 131.—Fruit of Hijli-badam or the Cashew-nut Tree, cut through downwards

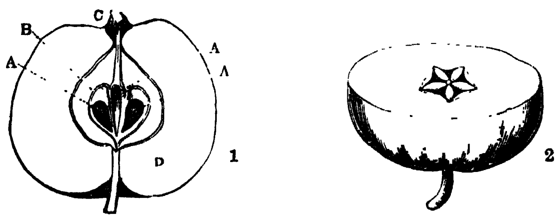


Fig. 132.—1, Longitudinal, and 2, Transverse Section of Apple

A, Seeds. B, Carpels. C, Withered calyx-lobes. D, Fleshy thalamus.

fruit is the jug-shaped thalamus, and the real fruits line the inner wall of the jug, and look like so many

seeds. In Strawberry the thalamus grows into a swollen rounded mass with the seed-like fruits scattered on it (fig. 134). All such fruits are termed SPURIOUS or false, as portions other than the ovary take an important part in their formation. Fruits which are formed from the ovary alone are therefore called TRUE by way of distinction.

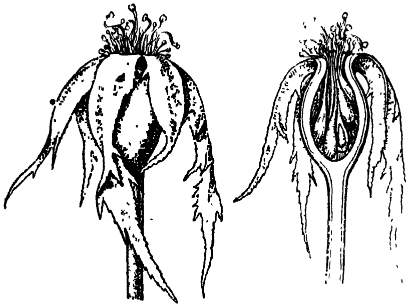


Fig. 133.--Hip of the Rose

A, Whole fruit. B, Longitudinal section.

Fruits like Pine-apple, **bot, aswathwa, dumur** (see fig. 72), **dalo** or **madar**, Jack-fruit (fig. 135), **toont** or Mulberry, and **kia** are formed by the perianth of a large number of flowers growing together with their ovaries and

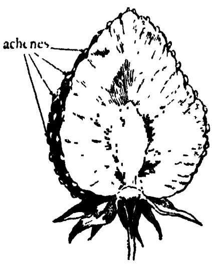


Fig. 134.—Section of Strawberry

Fig. 135.—Jack-fruit (*Artocarpus integrifolia*)

m.s., Male spike. *f.s.*, female spike.

forming a collective mass. These fruits are therefore spurious in the sense explained above, and as each of them is not the product of a single flower, but of many flowers or of an inflorescence, they are also known as COLLECTIVE fruits. In the Jack-fruit, for instance, when the skin and the edible parts are removed, a long, fleshy, more or less cylindrical stalk is exposed, which is nothing more than the axis or rachis of the spike or spadix which matures into the fruit. Every conical bit on the skin of the fruit represents a single flower of the inflorescence, from the conglomeration of which the fruit has been formed. Such a succulent collective fruit is known as a SOROSIS. The fruit of **toont** or Mulberry is also a sorosis. The fruit of **aswathwa, bot**, and **dumur** consists of an excavated jug-shaped axis or rachis of an inflorescence within which are inserted the minute fruits which are popularly mistaken for seeds. Such a fruit has been named a SYCONUS. The structure of the latter fruits agrees closely with that of the hip of the Rose, but there is this essential difference between them: the former are the products of many flowers and the latter of only a single flower,

Fig. 136.—Pinus

c, Cone. *ca*, Carpellary leaf with two seeds. *s*, Winged seed removed.

and the jug-shaped body of the former is the excavated axis of an inflorescence, while the jug-shaped body of the latter is the excavated thalamus of a single flower. The fruits of *Coniferæ* (Pines), consisting of an axis on which are inserted hard thickened carpellary leaves and scales, are collective fruits usually of a conical shape, and are therefore known as CONES (fig. 136).

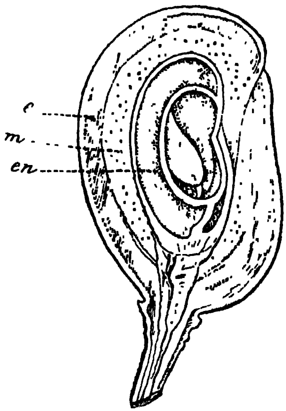


Fig. 137. - Mango or Am (*Mangifera indica*)

e, Epicarp. *m*, Mesocarp. *en*, Endocarp (stone).

The size and structure of the ovary usually undergo considerable changes during its transformation into a fruit. Thus, a small ovary may give rise to a big fruit, as **lau, kumrha, tarmuz, bael,** Cocoa-nut, Papaw, &c. The number of cells in an ovary and the number of seeds in each cell are often reduced during this transformation. For example, Cocoa-nut has a 3-celled ovary but a 1-celled fruit. On the other hand, the number of cells in an ovary may be increased during the transformation, as in Datura, which has a 2-celled ovary but a 4-celled fruit, the number of cells being doubled by the growth of spurious dissepiments. In Mustard a 1-celled ovary is rendered into a 2-celled fruit in the same way.

The wall of the ovary is termed PERICARP in the fruit. It may be thin and membranous, or thick and woody, or thick and fleshy. When thick it is usually divided into an outer layer called EPICARP and an inner layer called ENDOCARP; sometimes there is a

middle layer termed MESOCARP. For example, in Cocoa-nut the thick fibrous outer layer is the epicarp and the hard horny inner layer or shell is the endocarp. In the ripe Mango (fig. 137) the skin that we throw off is the epicarp, the pulpy layer that we eat is the mesocarp, and the hard horny layer is the endocarp. The hard horny endocarp in Mango and similar fruits is called STONE or **anti**. In **khejur** the epicarp is thin and crustaceous, the mesocarp is pulpy, and the endocarp thin, white, and membranous, enclosing one horny seed which must not be mistaken for a stone. In **tal**-palm there are one, two, or, more often, three stones, which must not be mistaken for seeds; each stone encloses a single seed.

CLASSIFICATION OF FRUITS.—Fruits are classified in various ways, and have received various special names, into the intricacies of which we do not wish to enter, as it will serve no useful or practical purpose. We shall content ourselves with a simple classification, and illustrate it with a few commonly occurring examples. The fruits we divide first into two groups, namely, (1) SIMPLE fruits, that is, fruits which are the products of a single flower, and (2) COLLECTIVE fruits, that is, fruits which are the products of many flowers conglomerated together. The simple fruits may be true or spurious, but aggregate fruits are always spurious. The simple fruits are either (*a*) DEHISCENT or (*b*) INDEHISCENT, according as the pericarp breaks open to expose the seeds or does not do so. The commonly occurring simple dehiscent fruits are as follows:—

(*a*) *Simple Dehiscent Fruits.*—(1) Follicle, (2) Legume, (3) Siliqua, and (4) Capsule.

A FOLLICLE is an apocarpous, simple, 1-celled, many-seeded, usually long fruit, which dehisces by

the ventral suture only, as in **akanda** (see fig. 123) and **karabi**; or occasionally by the dorsal suture only, as in **champa**.

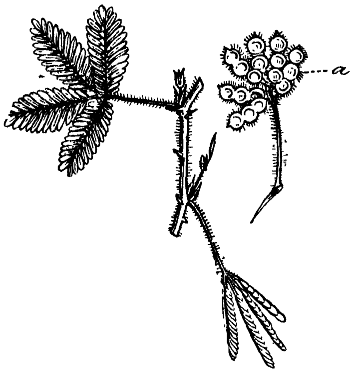


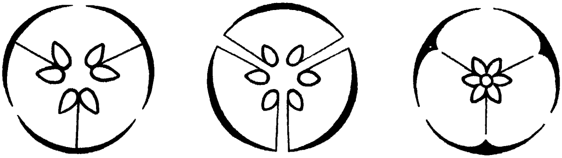
Fig. 138.—Lajwabati (*Mimosa pudica*) *a*, lomentum.

A LEGUME is a follicle which dehisces by both the sutures, so that the pericarp divides into two halves or valves as they are called, as in Pea (see fig. 91), **moog, arhahar, shone,** and **kal-kasonda.** In some legumes transverse spurious dissepiments are formed between the seeds, so that the cell-cavity is not continuous, but divided into one-seeded compartments, and the fruit when ripe does not dehisce at the sutures, but breaks up transversely into one-seeded segments. Such a legume is distinguished as a LOMENTUM, as in the sensitive plant or **lajwabati** (fig. 138), **shola, mat-kalai** or **chiner-badam,** and **gila** (*Entada*). In a legume or lomentum the pericarp is often constricted and compressed transversely between the seeds. Legumes are popularly known as PODS; in fact, all long fruits are so called.

Fig. 139.—Siliqua

A SILIQUA (fig. 139) is a syncarpous fruit with two carpels, originally one-celled, but rendered two-celled by the growth of a spurious dissepiment called REPLUM. It is a pod which dehisces into two valves, from the bottom towards the top, leaving the replum standing in the

middle as a thin vertical plate, bearing seeds on both its margins, as in Mustard. When it is short and compressed the siliqua is called SILICULA, that is,



A B C

Fig. 140.—Diagrammatic Representation of Valvular Dehiscence

A, Loculicidal B, Septicidal. C, Septifragal.

small siliqua, as in Shepherd's Purse (*Capsella Bursa-pastoris*), a weed commonly occurring in cultivated fields during the cold season.

A CAPSULE is the name given to all other dehiscent fruits which arise from a syncarpous many-seeded ovary. Capsules dehisce usually in five different ways, namely, (1) SEPTICIDALLY—B (fig. 140), that is, along the septas, as in **petari** (*Abutilon*) and Linseed; (2) LOCULICIDALLY—A, that is, along the dorsal sutures, so as to expose the loculi, as in Cotton and Anatto; (3) SEPTIFRAGALLY—C, that is, along the dorsal sutures, together with the breaking across of the septa, as in Datura; (4) CIRCUMSCISSILELY (fig. 141), when a portion of the pericarp separates like a cap, as in **nunia-shag** and **sada-morag-phul** (*Celosia argentea*), a common winter weed in Mustard and Pea fields; and (5) by PORES or small openings in the pericarp, as in Poppy (fig. 142) and *Antirrhinum*. The first

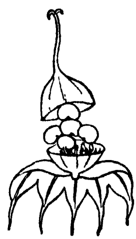


Fig. 141.—Circumscissile Dehiscence of Fruit of Sada-morag-phul (*Celosia argentea*)

three forms of dehiscence are collectively called VALVULAR, as the segments into which the pericarp breaks up are like so many valves. Usually the valvular dehiscence is complete, extending from the top of the capsule to its bottom, but occasionally it is incomplete, extending from the apex down to a certain distance below, as in **shial-kanta.**

(*b*) *Simple Indehiscent Fruits.*—Indehiscent fruits may be classified in two groups, namely, (1) those with a fleshy pericarp, and (2) those with a membranous or woody pericarp. The first group consists of two forms, namely, (i) DRUPE or DRUPACEOUS, when the fleshy fruit is one-seeded or occasionally two-seeded; and (ii) BERRY or BERRY-LIKE (bacca or baccate), when the fleshy fruit is many-seeded. A typical drupe is commonly called a STONE FRUIT, such as Mango (see fig. 137), in which the pericarp consists of a thin epicarp, a fleshy mesocarp, and a bony endocarp enclosing one seed. The bony endocarp in a drupe is known as a stone or **anti.** The fruit of **tal**-palm is also a drupe, but it is often two- to three-seeded. Date or **khejur** is drupe-like or drupaceous, but not a true drupe, because the hard stone inside is not an endocarp. Fruits like **kala-jam** are also drupaceous. Guava, Papaw, Plantain, &c., are examples of berry. Fruits like **bael,** Water-melon or **tarmuz,** Orange, &c., are berry-like or baccate. The second group of indehiscent fruits is either (i) ACHENE, when the pericarp is thin, or (ii) NUT, when the pericarp is thick and woody. The fruit of **chhagal-bati** and Clematis (see fig. 144, *a*)

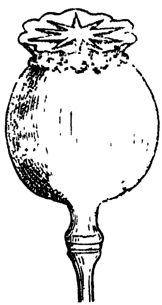


Fig. 142.—Capsule of Poppy—Afing or Posto Plant (*Papaver somniferum*)

is a collection of achenes, the fruits of Sunflower and other plants of the same family may also be called achenes. Rice, usually named CARYOPSIS, is also an achene (see fig. 8). Cocoa-nut, Betel-nut, &c., are nuts. The fruits in which the pericarp ex-

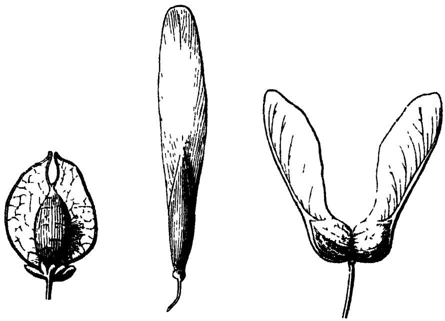


Fig. 143.—Samaras

pands into one or more flat limbs or wings are known as (iii) SAMARA (fig. 143) or winged fruit, as **madhabi-lata, chuprhi-aloo.**

An aggregate fruit, like that of **aswathwa, bot,** and **dumur,** is known as SYCONUS; if like that of Pine-apple, Mulberry, *Pandanus* (**kia**), or Jack-fruit (**kantal**) it is known as SOROSIS; and those like the fruits of *Coniferæ* are CONES.

A TABULAR STATEMENT OF FRUIT-CLASSIFICATION

- I. Product of One Flower (simple).
  - (*a*) Dehiscent.
    1. Follicle.
    2. Legume.
    3. Siliqua.
    4. Capsule.
  - (*b*) Indehiscent.
    1. With Fleshy Pericarp.
       - (i) Drupe.
       - (ii) Berry.
    2. With Membranous or Woody Pericarp.
       - (i) Achene.
       - (ii) Nut.
       - (iii) Samara.
- II. Product of Many Flowers (collective).
  1. Syconus.
  2. Sorosis.
  3. Cone.

PART II.—CLASSIFICATION

CHAPTER I

CLASSIFICATION AND NOMENCLATURE

The plants existing in the world are so large in number and so varied in form that it is impossible to study them without first arranging them into some sort of groups or classes, that is, without classifying them. They have been classified in two ways, namely, (1) by placing together in a group those plants that resemble one another in some one prominent character, or (2) by placing together in a group those plants that resemble one another in a number of prominent characters indicating a close relationship amongst them. The first system of classification is like arranging words in a dictionary in an alphabetical order without any reference to their etymological or other relationships. It therefore often separates closely allied plants and places them in different groups, simply because of the want of one character, or brings together quite different plants and places them in the same group, because of the presence of that character. Such a system of classification has therefore been termed ARTIFICIAL. The other system brings together into a group only those plants which resemble one another in a number of important characters, indicating close relationship amongst them, and separates

from it others which are wanting in all, or almost all, these important characters. The second system of classification has therefore been termed NATURAL.

There are several artificial systems of classification, but the one which is of special importance to Indian students is the LINNEAN SYSTEM, named after Linnæus, the father of Botany. It is also known as the SEXUAL SYSTEM, because it is based on the number and conditions of the sexual organs (stamens and carpels). Its special importance lies in the fact that the only easily available book describing the plants of India is (Clarke's edition of) *Roxburgh's Flora Indica* (R.F.I), which is based on the Linnean system. In this system the plants have been primarily divided into 24 CLASSES, according to the number, nature, and distribution of the stamens. Thus, plants with one stamen are placed in the Class Monandria, those with two stamens in the Class Diandria, and so on. These classes are further divided into ORDERS, according to the number of their styles or stigmas, or according to the number and condition of stamens which have not been used as the basis of Classes, or according to the nature of flowers or fruits. Thus plants with one style or stigma are placed in the Order Monogynia, those with two styles or stigmas in the Order Digynia, and so on. A detailed scheme of the Linnean system of classification as adopted in Roxburgh is given below:—

LINNEAN SYSTEM OF CLASSIFICATION, A SYNOPSIS OF

	Class.	Order.
1.	Monandria	Monogynia
2.	Diandria	Monogynia. Trigynia.
3.	Triandria	Monogynia. Digynia. Trigynia.
4.	Tetrandria	Monogynia. Digynia. Tetragynia.
5.	Pentandria	Monogynia. Digynia. Trigynia. Pentagynia.
6.	Hexandria	Monogynia. Digynia. Trigynia. Hexagynia.
7.	Heptandria	Monogynia.
8.	Octandria	Monogynia. Trigynia. Tetragynia.
9.	Enneandria	Monogynia. Hexagynia.
10.	Decandria	Monogynia. Digynia. Trigynia. Pentagynia. Decagynia.
11.	Dodecandria	Monogynia. Trigynia.
12.	Icosandria	Monogynia. Digynia. Pentagynia. Polygynia.
13.	Polyandria	Monogynia. Tetragynia. Pentagynia. Polygynia.
14.	Didynamia	Gymnospermia. Angiospermia.

Class.	Order.
15. Tetradynamia	Siliculosa. Siliquosa.
16. Monadelphia	Pentandria. Hexandria. Decandria. Dodecandria. Polyandria.
17. Diadelphia	Triandria. Hexandria. Octandria. Decandria.
18. Polyadelphia	Icosandria. Polyandria.
19. Syngenesia	Æqualis. Superflua. Frustranea. Segregata.
20. Gynandria	Monandria. Hexandria.
21. Monœcia	Monandria. Diandria. Triandria. Tetrandria. Pentandria. Hexandria. Polyandria. Monadelphia. Syngenesia. Gynandria.
22. Diœcia	Monandria. Diandria. Triandria. Tetrandria. Pentandria. Hexandria. Enneandria. Decandria. Icosandria. Polyandria. Monadelphia.
23.[1] Polygamia	Monœcia. Diœcia. Triœcia.
24. Cryptogamia	Miscellanea. Filices.

[1] *N.B.*—This Class finds no place in F. I. (Clarke's edition).

The Orders are next divided into GENERA, and the genera into SPECIES. Thus the plants under the Class Monandria, Order Monogynia, are divided into Genera CANNA, PHRYNUM, CURCUMA, ZINGIBER, &c. Each of these Genera is divided into one or more Species, as CANNA into Species INDICA, ZINGIBER into Species OFFICINALE (ada), &c. These Genera and Species have, however, been mostly retained in the Natural System of Classification, as they are based on the resemblance of many important characters. Genera and Species are defined below.

In the natural system the Vegetable Kingdom has been divided primarily into two Sub-kingdoms, namely, (1) Phanerogamia, commonly called flowering plants, which produce flowers with stamens or pistil, or both, and usually a perianth; and are reproduced by SEEDS, which are many-celled bodies containing an embryo: and (2) Cryptogamia, commonly called flowerless plants, which do not produce flowers with stamens or pistil, and are reproduced by SPORES, which are one-celled and contain no embryo. The former are often called SEED-PLANTS or SPERMAPHYTA, and the latter SPORE-PLANTS or SPOROPHYTA.

The Phanerogamia are classified into two Divisions, namely, (1) *Angiospermia* or covered-seeded plants, in which the seeds are contained within closed carpellary leaves or ovaries, and the pollen-grains do not fall directly on the micropyle of the ovule, but upon the stigma; and (2) *Gymnospermia* or open-seeded plants, in which the seeds are produced on open carpellary leaves and not enclosed in an ovary, and pollen-grains fall directly on the micropyle of the ovule. The Division *Angiospermia* includes the large majority of flowering plants, while the Division *Gymnospermia*

is a comparatively small group, and seldom met with in the plains of India, excepting in gardens.

The *Angiospermia* are divided into two classes, namely, (1) *Dicotyledons*, which bear two opposite cotyledons in their embryo the radicle of which usually elongates into a tap-root in germination, and which have usually reticulate leaves, flowers with 5-merous or 4-merous, or 2-merous symmetry, and open fibrovascular bundles arranged in the stem and in the root in the form of a ring; and (2) *Monocotyledons*, which bear only one cotyledon in their embryo or occasionally two alternate cotyledons (never opposite) the radicle of which usually remains undeveloped and throws out a large number of fibrous roots in germination, and which have usually thick underground stems, non-reticulate parallel-veined sheathing leaves, flowers with 3-merous symmetry, and closed fibrovascular bundles scattered irregularly in the stem and the root.

The Classes *Dicotyledons* and *Monocotyledons* are subdivided into *Sub-classes*, the first into four and the second into three.

Class I.—DICOTYLEDONS

Sub-class 1, *Thalamifloræ*, in which the flowers are usually complete and hermaphrodite, corolla polypetalous, calyx inferior, corolla and stamens hypogynous, and ovary superior.

Sub-class 2, *Calycifloræ*, in which the flowers are usually complete and hermaphrodite, corolla polypetalous, calyx gamosepalous, inferior or superior, corolla and stamens either perigynous or epigynous, ovary superior or inferior.

Sub-class 3, *Gamopetalæ* or *Corollifloræ*, in which

the flowers are usually complete and hermaphrodite, corolla gamopetalous hypogynous or superior, calyx inferior or superior, stamens epipetalous or superior, ovary superior or inferior.

Sub-class 4, *Incompletæ*, in which the flowers are usually mono- or achlamydeous and unisexual. This in fact consists of the refuse of the last three sub-classes.

Class II.—MONOCOTYLEDONS

Sub-class 1, *Petaloideæ*, in which the perianth is usually petaloid.

Sub-class 2, *Spadicifloræ*, in which the flowers are arranged in a spadix usually enclosed in a spathe.

Sub-class 3, *Glumiferæ*, in which the flowers are inconspicuous and enclosed in bracts called GLUMES, and perianth absent or represented by minute scales or bristles.

Each of the Sub-classes is further divided into a number of *Natural Orders*, each *Order* usually comprising a number of *Genera*, and each *Genus* comprising a number of *Species*.

The Division *Gymnospermia* includes a comparatively small number of plants. Hence it is not necessary to divide it into such intermediate groups as Classes or Sub-classes, but it is at once divided into Natural Orders, Genera, and Species. There are several systems of natural classification, but the one sketched above, and adopted in this book, is generally used in this country. A tabular view of this is subjoined:—

A TABULAR VIEW OF THE NATURAL SYSTEM OF CLASSIFICATION ADOPTED IN THIS BOOK[1]

VEGETABLE KINGDOM.

- *Sub-kingdom I* **Phanerogamia.**
  - *Division I* ANGIOSPERMIA.
    - *Class I* DICOTYLEDONS.
      - *Sub-class I* Thalamifloræ. — Natural Orders. — Genera. — Species.
      - *Sub-class 2* Calycifloræ. — Natural Orders. — Genera. — Species.
      - *Sub-class 3* Gamopetalæ — Natural Orders. — Genera. — Species.
      - *Sub-class 4* Incompletæ. — Natural Orders. — Genera. — Species.
    - *Class 2* MONOCOTYLEDONS
      - *Sub-class I* Petaloideæ — Natural Orders. — Genera. — Species
      - *Sub-class 2* Spadicifloræ. — Natural Orders. — Genera — Species
      - *Sub-class 3* Glumiferæ — Natural Orders — Genera. — Species.
  - *Division 2* GYMNOSPERMIA. — Natural Orders. — Genera. — Species.
- *Sub-kingdom II* **Cryptogamia.** (To be dealt with later on in another part)

[1] The admirable system of Eichler, in recent years much elaborated by Engler and Prantl, has been sketched out in the Appendix A and B, but has not been followed in this book because of the universal adoption of Hooker's system in this country.

The key-note of classification is the conception of what constitutes a SPECIES and what constitutes a GENUS. The term species is applied to a collection of individual plants which resemble one another in all the important characters of their vegetative and reproductive organs, and are therefore supposed to be descended from a common ancestor. Thus, for example, take the **ata** (*Anona squamosa*) plant. Individual **ata** plants may differ from one another in unimportant characters, such as the size of the plant, the size of the fruit, &c., but they resemble one another in all important characters, such as general appearance, the form, nature, and arrangement of leaves, and the structure of flowers, fruits, and seeds; and **ata** seeds produce **ata** plants from generation to generation. All **ata** plants in the world are therefore supposed to have descended from a common ancestor. Thus the entire collection of **ata** plants constitutes a species, say the **ata** species. So all **nona** plants (*A. reticulata*) constitute a second species, say the **nona** species; all **bat** or Banyan trees (*Ficus bengalensis*) constitute a third species, say the **bat** species; all **aswathwa** or Peepul (*F. religiosa*) trees a fourth species, say the **aswathwa** species: and all **dumur** plants (*F. hispida*) a fifth species, say the **dumur** species.

Now of these five species, **ata** and **nona** species of plants resemble one another more closely than they resemble the other three species. Thus **ata** and **nona** species of plants resemble one other in the structure of their reproductive organs, and differ completely from the other three species in the same respects. These two species are therefore thrown into one group, and that group is named a GENUS. Thus a genus may be defined as a collection of species which

resemble one another in the structure and character of their reproductive organs. Now these two species, which have been thrown together in the same genus for their resemblances in reproductive organs, differ from one another in the structure of their vegetative organs, such as the form of the leaf, general appearance of the plant, form of the fruit, &c. For example, **ata** plants have leaves obtuse, peduncles solitary, and fruit with projecting convex ovoid patches on its surface, whereas **nona** plants have leaves acuminate, peduncles generally 2 to 4 together, and fruit marked on the surface with flat 5-cornered patches. Two or more species belonging to the same genus, therefore, differ from one another only or mainly in the characters of their VEGETATIVE organs. Similarly, the other three species, namely, **bat**, **aswathwa**, and **dumur**, closely resemble one another in the characters of their reproductive organs. These three species are therefore thrown together under one genus. These three species, however much they may resemble one another in their reproductive organs, namely, inflorescence, flower, fruit, and seed, differ completely in the characters of their vegetative organs, such as leaves, general appearance, &c. It is clear from this that GENERIC CHARACTERS are taken mainly from the reproductive organs, and SPECIFIC CHARACTERS mainly from the vegetative organs.

Among plants of the same species it sometimes happens that in the course of multiplication new forms arise with new peculiarities of a more or less permanent character. These forms are known in classification as VARIETIES. They are supposed to be due to changes in the environment of the species, such as soil, moisture, heat, and other external factors of life. Thus, for example, **krishna-moog** and **sona-moog**

belong to one and the same species, but are classed as two different VARIETIES of it. For the seeds of **sona-moog** are golden-yellow, leaves pale-green, and pods reflexed; whereas the seeds of **krishna-moog** are black, leaves darker green, and pods spreading horizontally. These differences are permanent, but not important enough to be considered as specific. A VARIETY differs from a species in the fact that a change in its environment, and in other external conditions of growth, tends to make it revert to the parent species from which it has sprung.

On the same principle of resemblances and differences, the genera that resemble one another more closely than they resemble other genera are thrown into groups known as Natural Orders. Similarly, Orders are grouped into Sub-classes, Sub-classes into Divisions, Divisions into Sub-kingdoms, till we arrive at the whole collection of plants known as the Vegetable Kingdom. When a particular group is very large, it has often to be subdivided into intermediate groups, as Sub-classes into Cohorts, Orders into Sub-orders, Genera into Sub-genera, and so on.

NOMENCLATURE.—The naming of plants is a part of classification, and as such it demands our attention. Every species of plants has a name by which it is distinguished from all other species. Thus **ata** species is named *Anona squamosa*, **dhutura** species is named *Datura Stramonium*, and **aloo** species is named *Solanum tuberosum*, &c. The name of each plant thus consists of two parts; the first part indicates the genus to which the plant belongs, and the second part indicates the species to which the plant belongs. Thus it will be seen that the three plants named above not only belong to three different species, but also to three different genera. The first part of the name is

GENERIC and the second part SPECIFIC. Two or more species belonging to the same genus have, of course, the same generic name, as, for example, **ata** and **nona** belong to the same genus, *Anona*, and are named *Anona squamosa* and *Anona reticulata* respectively, the specific parts of the names—*squamosa* and *reticulata* respectively—indicating the two different species to which they belong. Similarly, **bat**, **aswathwa**, and **dumur** are the three species of one and the same genus *Ficus*, and are named *Ficus bengalensis*, *F. religiosa*, and *F. hispida* respectively.

This system of naming plants is known as the Binomial Nomenclature, because each name is made up of two parts, the first part generic and the second part specific. To take an illustration from the science of chemistry, which has also a similar nomenclature. Thus potassium sulphate, sodium sulphate, and calcium sulphate are three different substances (salts), all of which belong to the same genus, SULPHATE, and are distinguished from one another by the specific names of POTASSIUM, SODIUM, and CALCIUM respectively. Similarly, in almost all civilized societies human beings have binomial names. Thus Romes Chatterji and Pares Chatterji are two individuals who belong to the same family or genus, Chatterji, and are distinguished from each other by the individual or specific names, namely, Romes and Pares respectively. In these latter illustrations the order of placing the two parts of the name is the reverse of that which is followed in plants.

Since the same plants have often been described under different names by different botanists, and also different plants have often been designated by the same name, it is necessary, for the purpose of avoiding confusion, to append to the name of the plant the

name of the botanist who is the authority for it. Thus, for example, the common **debdaru** tree of Bengal has been designated by three different names, namely, *Uvaria longifolia* Lamk., *Guatteria longifolia* Wall., and *Polyalthia longifolia* Benth. and Hk.; and each of these names, to prevent confusion, is followed by an abbreviation indicating the name of the botanist who is the authority for it, namely, Lamk. for Lamarck, Wall. for Wallich, and Benth. and Hk. for Bentham and Hooker. In India the latest and the most authoritative book dealing with the description and naming of Indian plants is Hooker's *Flora of British India* (F.B.I.). Hooker's nomenclature, as modified occasionally by Dr. Prain, has been adopted in this book. This nomenclature differs, in many instances, from that adopted in the classical *Flora Indica* (F.I.) by Dr. Roxburgh, a book written about a century ago, and based on the Linnean system. Bengal is also fortunate in having *Bengal Plants*, by Dr. Prain, a very valuable book of reference in which Hooker's nomenclature has been generally followed. Roxburgh's *Flora Indica*, edited by Clarke, though antiquated, is of unique value to students of Indian botany, as it is practically the only *Flora of India* within their easy reach, both Hooker's *Flora* and Dr. Prain's *Bengal Plants* being much too high priced and difficult to procure (perhaps out of print). Throughout this book the abbreviations which indicate the authority for the names have, as a rule, been omitted for reasons already stated above.

CHAPTER II

Sub-kingdom: PHANEROGAMIA—Division 1: ANGIOSPERMIA—Class 1: DICOTYLEDONS—Sub-class 1: THALAMIFLORÆ.

Nat. Order 1. *Ranunculaceæ*.—Herbs or climbing shrubs, often growing in marshy places. Leaves

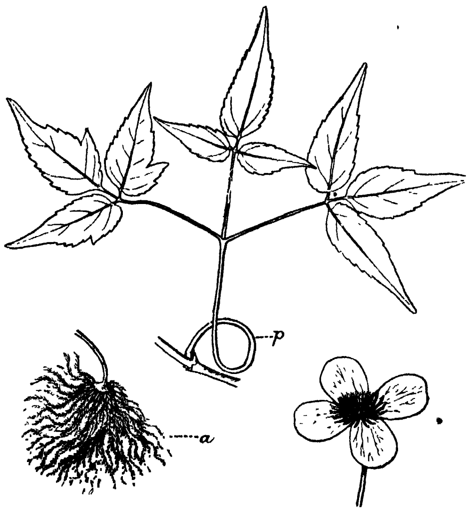


Fig. 144.—*Clematis montana*

p, Petiole coil as tendril. *a*, Cluster of achenes (fruits) with persistent hairy styles.

usually radical or alternate, with sheathing petioles. Flowers regular or irregular. Sepals 5, often coloured like petals. Petals usually 5, often spurred, or 0. Stamens usually numerous and free. Carpels usually numerous and free.

The Order is not of much importance in Indian botany, as the plants belonging to it are mostly confined to temperate regions. The common wild plants of Bengal are **chhagalbati** (*Naravelia zeylanica*), a climber with ternate leaves, the terminal leaflet of which is converted into a tendril; *Ranun-*

Fig. 145.—*Anemone rivularis*

f, Head of Achenes.

culus sceleratus (Plate IV, fig. A), an erect herb, found generally on the banks of rivers and marshes; *Clematis Gouriana*, *C. montana* (fig. 144), herbs climbing by twisting the petiole; *Anemone rivularis* (fig. 145), a common roadside herb in Shillong (Assam) with star-shaped white flowers. The commonly cultivated garden annuals are Larkspur (*Delphinium*) and Monkshood or Aconite (*Aconitum*)

(fig. 146). *Nigella sativa* or **kala-jira** is cultivated for its seeds, which are largely used as a condiment and also as a preservative of clothes against the attack of vermin. The common Buttercups of English pastures are a species of *Ranunculus*, found in Darjeeling. The Order is mostly ENTOMOPHILOUS. In

Fig. 146 Kat-bish or Monkshood (*Aconitum heterophyllum*)

r, Root. *f*, Head of follicle.

Ranunculus sceleratus the yellow flowers make the plant conspicuous in spite of the smallness of the individual flowers.

Nat. Order 2. *Dilleniaceæ.*—Trees or shrubs with alternate leaves, sometimes climbing. Sepals 5 or 4, persistent. Petals 5 or 4. Stamens and carpels many and free.

This is a tropical order, of which one example is very common, namely, **chalta** (*Dillenia indica*). The large handsome white caducous fragrant petals of the

A. *Ranunculus sceleratus*

B. *Uvaria macrophylla*
(bagh ranga)

flower serve to attract insects. The 5 imbricate sepals grow along with the fruit, of which they form the edible part. *D. scabrella* (fig. 147) and *D. aurea* are kinds of **chalta** that grow wild in the forests of E. Bengal and Assam.

Nat. Order 3. *Anonaceæ*.—Trees or shrubs, sometimes climbers, with naked buds. Leaves alternate, entire, exstipulate. Flowers with trimerous perianth. Sepals 3, valvate. Petals thickish, 6 in 2 whorls, valvate. Stamens free and close set on an elongated thalamus. Carpels many, free, mostly packed together on the prolonged thalamus, style 0. Ovules 1 or more, anatropous. Fruit of a number of 1 to many-seeded free indehiscent carpels; rarely, as in *Anona*, the carpels are confluent. Seeds large, with ruminated or marbled albumen.

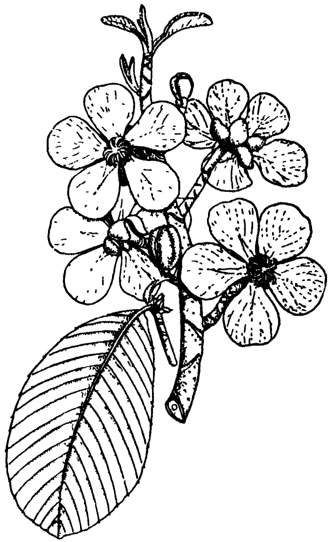


Fig. 147.—*Dillenia scabrella*, a kind of wild Chalta

This is a tropical order, represented by the following well-known plants, namely, **ata** or Custard-apple (*Anona squamosa*), **nona** or Bastard-apple (*Anona reticulata*), **debdaru** (*Polyalthia longifolia*), and **kantali-champa** (*Artabotrys odoratissima*), climbing by the help of recurved hooks on the peduncles of the flowers. It has sometimes straight spines also, which are modified branches. The pulpy fruits of **ata** are

delicious, and those of **nona** indifferent, but both are largely eaten by birds and other animals, whereby the seeds are dispersed. *Uvaria macrophylla* is a climbing shrub of E. Bengal, conspicuous for its leaves and red flowers (Plate IV, fig. B).

Nat. Order 4. *Magnoliaceæ*. — Trees or shrubs, sometimes climbing. Leaves alternate, simple, usually entire, with bud-scales or stipules covering the buds. Flowers usually aromatic, showy yellow, white, or pink. Sepals 3, green or petaloid. Petals in 2 or more whorls of 3 each, imbricate. Stamens and carpels as in *Anonaceæ*. Fruit a collection of berries or follicles dehiscing by dorsal sutures. Seeds 1 or few. Albumen not ruminated.

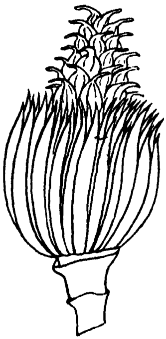


Fig. 148. – Champa (*Michelia Champaca*): flower with perianth removed

It is chiefly tropical. The common plants are **champa** (*Michelia Champaca*) (fig. 148), with yellowish perianth in several whorls, **dulee-champa** (*Magnolia pterocarpa*) with 3 green sepals and 6 white petals in two whorls, and *Magnolia grandiflora*, all of which produce fragrant protogynous bee-flowers. The flowers of *Magnolia grandiflora* look like those of **padma** (*Nelumbium speciosum*), and are often mistaken for the latter when removed from their setting. *Magnolia Campbellii* of Darjiling is well known for its handsome flowers. The trimerous perianth of *Anonaceæ* and *Magnoliaceæ* is unusual and exceptional amongst Dicotyledons. The Order is entomophilous.

Nat. Order 5. *Menispermaceæ*.—A tropical Order of climbing plants with diœcious 3-merous flowers, represented by the well-known plant **golancha** (fig. 149) (*Tinospora cordifolia*), used in the Indian pharma-

copœia as a febrifuge. The structure of its stem is very characteristic, the ducts in a transverse section being visible with the naked eye.

Nat. Order 6. *Berberidaceæ.*—Spinous shrubs or herbs with compound leaves, bisexual flowers, sepals and petals each in 2 or more whorls of 2, 3, or 4 each, and anthers with valvular dehiscence. The common Barberry plant of England is the well-known host of the heteromorphous Wheat-rust Fungus. The Order is of little importance in this country.

Fig. 149.—Golancha (*Tinospora cordifolia*)

Nat. Order 7. *Papaveraceæ.* — Herbs with milky or coloured juice. Leaves lobed, radical or cauline, alternate, stipules o. Peduncles mostly 1-flowered. Flowers regular, often showy. Sepals 2, imbricate, caducous. Petals 4, in 2 whorls, crumpled. Stamens many, free, anthers basifixed. Carpels 2 or more, connate, in a 1-celled ovary, with parietal placentas, often chambered, style o; stigma capitate; ovules many, anatropous. Fruit a capsule dehiscing by pores (see fig. 142) or by teeth; seeds many, albumen oily.

The Order is chiefly natives of the North Temperate Zone. Two common plants are **posta, afing** or Poppy (fig. 150) (*Papaver somniferum*) and **shial-kanta** (*Argemone mexicana*) (fig. 63). The trimerous perianth of the last plant is rather unusual in this order. The Poppy has been cultivated in India from very early

times for opium, which is the inspissated milky juice of the unripe capsule. The seeds of Poppy and **shial-kanta** yield a kind of oil which is used for lighting purposes. *Papaver orientale* and *P. Argemone* are commonly grown in gardens during winter. The Order is characterized by mostly homogamous pollen flowers, like the two plants mentioned above.

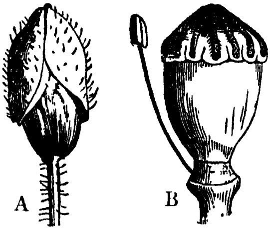


Fig. 150.—A, Opening Flower with Sepals caducous, and B, Pistil and Single Stamen of *Papaver*

Nat. Order 8. *Cruciferæ.*—Herbs, juice often pungent. Leaves radical, in a rosette, also cauline alternate. Stipules 0. Flowers in racemes, without bracts. Sepals 4, in 2 whorls,

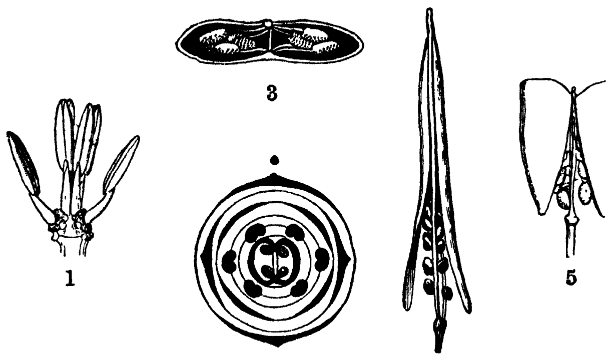


Fig. 151.—Cruciferæ

1, Tetradynamous stamens with nectaries or glands at their base. 2, Floral diagram. 3, Transverse section of silicula, showing replum. 4, Siliqua. 5, Silicula.

free, imbricate, the lateral pairs often gibbous at the base. Petals 4, clawed, cruciform. Stamens 6, tetradynamous (fig. 151), 2 short ones in the outer whorl

opposite the lateral sepals, 4 long ones in the inner whorl, antero-posterior, usually with 4 glands on the thalamus between the stamens opposite the sepals. Ovary composed of 2 carpels, initially 1-celled with 2 parietal placentas, subsequently rendered 2-celled by a false dissepiment (replum) thrown across the ovary from placenta to placenta; style short or 0; ovules many, campylotropous. Fruit siliqua or silicula. Distributed chiefly in the temperate regions of the Old World.

The species cultivated as economic plants are the different kinds of **sharisha** or Mustard and Rape, namely, *Brassica juncea*, *B. campestris*, and *B. Napus*; the different varieties of **kapi**, such as **bandha-kapi** or Cabbage, cultivated for its leaves, **phul-kapi** or Cauliflower, cultivated for its inflorescence, and **ol-kapi** or Kohl-rabi, cultivated for its stem—these being all different varieties of *Brassica oleracea*; and **moola** or Radish (*Raphanus sativus*). Although the coloured petals and nectarial glands are undoubtedly an attractive apparatus, self-pollination is of frequent occurrence in this Order.

Nat. Order 9. *Capparidaceæ.*—Herbs or shrubs, erect or climbing. Leaves usually alternate, simple or compound-palmate. Stipules herbaceous or spinous or 0. Flowers often showy. Sepals usually 4, free or connate. Petals usually 4. Stamens 4 or 6 (not tetradynamous) or many, free, with long filaments. Ovary as in *Cruciferæ*, but usually borne upon a stalk (gynophore); style short or 0. Fruit a capsule (siliqua) or berry. Seeds many, reniform, exalbuminous. Chiefly tropical.

The three common weeds are **hurh-hurhe** with yellow flowers with unstalked ovary (*Cleome viscosa*), and **hurh-hurhe** with white or pale-purplish flowers

(*Gynandropsis pentaphylla*), with stamens separated from the corolla by an internode and ovary stalked, and *Capparis sepiaria* (**kanta-gur-kamai**) (see fig. 75), also with stalked ovary, a common hedge plant,

Fig. 152.—A, Flower, and B, Floral Diagram of *Fumaria*

climbing by means of stipular hooked spines. *Cleome viscosa* appears to have cleistogamous flowers. The Order is mostly entomophilous.

Nat. Order 10. *Fumariaceæ*.—This is represented by a small branched annual weed common in waste grounds (*Fumaria parviflora*) (fig. 152). It has dissected glaucous leaves and irregular purplish flowers with diadelphous stamens.

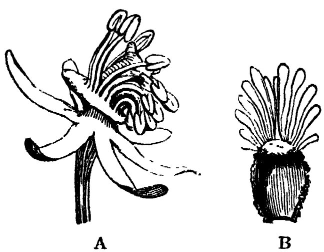


Fig. 153.—A, Flower of *Reseda* without the petals. B, Petal of *Reseda*.

Nat. Order 11. *Resedaceæ*.—This is represented by the common garden flower Mignonette (*Reseda odorata*) (fig. 153), noticeable for its three-lobed ovary open at the top, three parietal placentas, fruit remaining green even when mature, and also for its red-anthered one-sided cluster of stamens. Although small and inconspicuous, the flowers possess a sweet odour, and are commonly visited by bees. It has been observed by Darwin that self-pollination is infertile.

Nat. Order 12. *Nymphæaceæ.*—Perennial aquatic herbs with rhizomes embedded in the mud. Flowers solitary, on a naked scape. Leaves often peltate, floating. Perianth of many spirally-imbricated segments passing gradually from sepals to petals and from petals to stamens. Stamens many, the inner or all perigynous or some epigynous, adherent to the fleshy cup-shaped thalamus, which envelops and adheres to the pistil. Carpels usually adherent to the cup-shaped thalamus as a many-celled ovary; stigmas sessile, radiating; ovules mostly scattered on the wall of the ovary, but not under the ventral suture (superficial placentation). Fruit a fleshy berry-like mass. Seeds arillate or not, with both perisperm and endosperm (vitellus). Distribution both temperate and tropical.

Common plants are **shalook** (figs. 76 and 104), **rakta-kambal**, and **nil-padma** (*Nymphæa Lotus*, *N. rubra* Roxb., and *N. stellata*). *Euryale ferox* of East Bengal-tanks is known by the name of **kanta-padma** for its spinous leaves and fruits; the leaves are often 4 feet across. The *Nymphæa* have homogamous conspicuous pollen-flowers. *Victoria regia*, a South American species, is well known for its floating orbicular leaves, often measuring 12 feet across, and flowers about 1 foot across, and is comparable with *E. ferox*. A specimen of this may be seen in the Royal Botanical Gardens, Calcutta (Sibpur). The structure of the rhizome is more of a Monocotyledonous type, and the habit is that of *Hydrocharidaceæ*.

Nat. Order 13. *Nelumbiaceæ.*—Similar to *Nymphæaceæ*, with the following points of difference: (1) Leaves rise above the surface of the water; (2) perianth with 4 to 5 sepals, many petals, all caducous; (3) stamens hypogynous, caducous; (4) carpels many,

discrete or separately sunk in the flat top of the obconic thalamus; and (5) seeds without albumen.

It is represented by the well-known sacred **padma** or Lotus (*Nelumbium speciosum*) (fig. 154), with its large peltate orbicular leaves standing out of the water, and big white solitary flowers on naked scapes also sticking out of the water. The long hollow petioles and peduncles of **shalook** and **padma** serve as air-passages to aerate the embedded rhizome. **Padma** is a conspicuous protogynous pollen-flower.

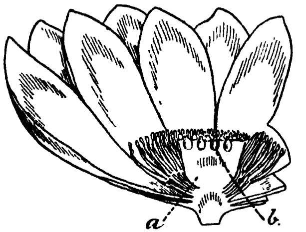


Fig. 154.—Section of Padma or Lotus Flower (*Nelumbium speciosum*)

a, Obconic thalamus. *b*, Imbedded carpels.

Nat. Order 14. *Violaceæ*.—This is an order of the temperate regions, represented in Bengal by the common garden annual Pansy or Heart's Ease (*Viola tricolor*), with irregular spurred flowers and expanded corollas showing colour contrast. The Order is characterized by the connective of the anthers being usually dilated or prolonged, connivent over the pistil, syncarpous unilocular ovary with three parietal placentas and small more or less closed cleistogamous flowers, while the ordinary showy flowers are seldom fertile.

Nat. Order 15. *Bixaceæ*.—Trees or shrubs, often spinous. Leaves alternate, simple. Stipules small, caducous, or o. Flowers hermaphrodite or unisexual. Petals as many as the sepals, imbricate or contorted, sometimes o. Stamens many, free. Ovary composed of 2 to many carpels, syncarpous, unilocular, with parietal placentation. Ovules 2 to many. Fruit a capsule with loculicidal dehiscence, or a berry. They are distributed chiefly in the tropics. The common

plants are **natkan** (*Bixa Orellana*) (fig. 155), cultivated for its seeds, the red pulpy covering of which affords a colouring-matter called **anatto**, used in dyeing, and

Fig. 155.—The Anatto Plant (*Bixa Orellana*) with Flowers and Fruit. Three of the fruits have opened showing the seeds. (After Baillon.)

staining butter; **bengchi** or **bonch** (*Flacourtia sepiaria*), a spinous shrub which yields a kind of edible berry; **pani-ala** or **pani-amrha** (*Flacourtia Cataphracta*), with the stem covered with compound spines (see fig. 62); *Cochlospermum Gossypium* or Yellow Cotton-tree;

Taraktogenos Kurzii, King, or **chal-moogra**, a tree of Chittagong, the seeds and oil of which are used in the cure of leprosy and other cutaneous diseases. The *Flacourtia* are spiny, and have small glabrous leaves with thick epidermis. They are thus adapted to grow in dry sandy places. The water that they can store up can hardly escape through the glabrous and thick-walled leaves, and is thus economized. Plants which thus conserve their water-supply are known as XEROPHYTES, as opposed to plants like *Nymphæa* and Lotus, which have no need to conserve water, and have therefore large leaves with thin epidermis, which allows free transpiration or escape of water. Such plants are therefore called HYDROPHYTES.

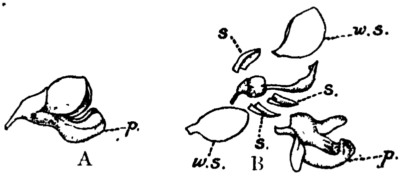


Fig. 156.—Meradu or Garadu (*Polygala chinensis*)
A, Whole flower (*p*, keel petal). B, Dissected flower (*s*, sepals, *w.s.*, wing sepals, *p*, keel petal).

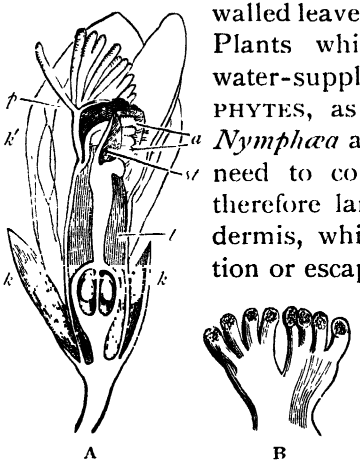


Fig. 157.—A, Vertical Section of Flower of *Polygala*. *k k*, outer sepals; *k'*, inner wing-like sepal; *p*, anterior fringed and keeled petal; *t*, staminal tube; *a*, anthers; *st*, stigma. B, Stamens spread out.

Nat. Order 16. *Polygalaceæ*.—This Order is represented by one well-known weed **meradu**, commonly met with in pastures (*Polygala chinensis*) (fig. 156), with orange-coloured small homogamous very irregular bee-flowers which resemble those of *Papilionaceæ*, but the wings belong to the calyx and not to the corolla,

and the stamens are monadelphous (fig. 157). *P. persicariæfolia* is a handsome herb met with in Shillong. *Xanthophyllum flavescens* (**gundhi**) is a large tree of Darjiling and hilly parts of Chittagong with yellow and pink panicles.

Nat. Order 17. *Caryophyllaceæ.*—This is mostly an Order of temperate regions, represented by the common garden annual Pink (*Dianthus chinensis*), with grass-like opposite glabrous leaves, swollen nodes, syncarpous ovary, free styles, and free central placentation. The flowers of Pink are protandrous and typical butterfly-flowers, the nectar being secreted and concealed at the bottom of the corolla-tube, which is formed by the long claws of the free petals held together like a tube by the gamosepalous calyx and stiff bracts. Pink is typical of the Order. *Gypsophila cerastioides* is a common season flower of gardens. In cool climates, like those of Darjiling and Shillong, species of *Spergula* (fig. 158), *Arenaria*, and *Drymaria* occur commonly as weeds. Cymose dichotomy or dichasium is the common form of inflorescence in this Order, and 2 to 5 free-styled flowers and free-central placentation are characteristic.

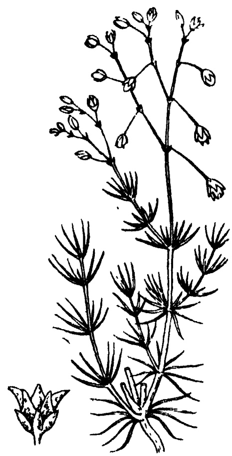


Fig. 158. -*Spergula arvensis*

Closely allied to it is the Nat. Order *Elatinaceæ*, which are minute marsh or water plants with bisexual flowers and 3 to 5 styles.

Nat. Order 18. *Portulacaceæ.* — Herbs. Leaves usually succulent. Flowers regular. Sepals usually

2. Petals 4 to 5. Stamens 4 to many. Ovary syncarpous 1-celled; styles free. Fruit a capsule opening circumcissilely. Seeds 1 to many, albuminous.

It is chiefly an American Order. It is represented in Bengal by three species of **nunia-shag**, namely, *Portulaca oleracea*, *P. quadrifida*, and *P. tuberosa*, weeds very common in waste lands and roadsides. The golden-yellow flowers of these three species are devoid of nectar and odour, and open for about three to four hours on sunny mornings and then close finally (pseudo-cleistogamous). The stigmas lie between the anthers in such a way that automatic self-pollination is inevitable. The bright-yellow colour and the presence of ants in the flowers now and again suggest occasional cross-pollination. *Portulaca grandiflora* is a common garden annual having showy red-coloured pollen-flowers with sensitive stamens.

Fig. 159.—Lal-jhau (*Tamarix gallica*)

Nat. Order 19. *Tamaricaceæ.*—It is an Order almost confined to sandy and saline places and is represented in Bengal by **lal-jhau** and **ban-jhau** (*Tamarix gallica* and *T. dioica*) (fig. 159), two shrubs found in the islands and sandy banks of the Hooghly, above the village of Sooksagar, and in other similar places. They have the structure and habit of xerophytes. These plants must not be confounded with the big **jhau** or Beef-wood tree, commonly grown in avenues, which belongs to the Nat. Order *Casuarinaceæ*.

Nat. Order 20. *Hypericaceæ.*—Herbs or shrubs, leaves simple, opposite, dotted with glands. Flowers

usually 5-merous, stamens indefinite, 3- to 5-delphous, rarely free. Ovary of 3 to 5 carpels, syncarpous, pla-

Fig. 160.—*Hypericum Hookerianum*. Flower isomerous, stamens $\propto$, 5-delphous

centation usually parietal; styles as many as the carpels, usually free. It is an Order of temperate regions and the mountains of warm regions. *Hypericum Hookerianum* (fig. 160) and *H. japonicum* (fig. 161) are common wild shrubs and herbs respectively of the Khasi Hills.

Fig. 161.—*Hypericum japonicum* (with dotted leaves)

Nat. Order 21. *Gutti-feræ*.—Trees or shrubs, with resinous juice, leaves opposite, coriaceous, simple. Flowers unisexual or polygamous, sepals in 2 or more decussating pairs, stamens indefinite, seeds exalbuminous.

It is a large tropical Order, represented in northern India by the following species of trees, namely,

Garcinia Cowa or **cowa** tree of Chittagong, *G. Xanthochymus* or **dainphal** of Sylhet and Chittagong, and *G. pedunculata* (fig. 162) or **tikoor** of Rungpur, all of which yield fruits with edible aril. *Garcinia Mangostana* yields the fruit Mangosteen, imported into Calcutta from Singapur for its delicious aril. *G. speciosa* of Andaman Islands is a similar tree. *Calophyllum inophyllum* or **pun-nag** or **sultan-champa** is a handsome middle-sized tree, often planted for its beautiful coriaceous leaves. **Nag-kesar** or **nagessur** (*Mesua ferrea*)

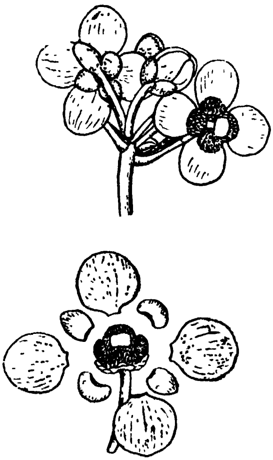


Fig. 162.—Tikoor (*Garcinia pedunculata*)

Fig. 163.- Nag-kesar (*Mesua ferrea*)

(fig. 163) is an elegant tree, often found in gardens, with large delightfully-fragrant white flowers, having curled petals and a large globe of bright gold-coloured anthers in the centre.

Nat. Order 22. *Ternstrœmiaceæ.*—Trees or shrubs, with alternate coriaceous simple exstipulate leaves. Flowers hermaphrodite, rarely unisexual, stamens indefinite, ovary many-celled, styles free, seeds with or without endosperm.

It is an Order of tropical Asia, represented in Bengal by the well-known **cha** or tea-plant (*Camellia*

Thea, **Link**), which is said to grow wild in the jungles of Assam. *Eurya acuminata* is a Chittagong and East Bengal plant.

Nat. Order 23. *Dipterocarpaceæ.*—Large trees with abundant resinous juice, alternate pinni-veined stipulate leaves. Calyx 5-lobed, persistent, and fruit enclosed by the enlarged calyx, two or more lobes of which form wings.

It is a tropical Order, chiefly of eastern Asia, and

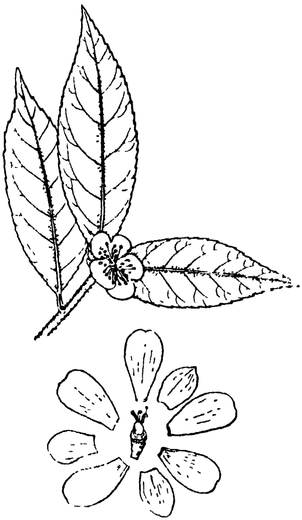


Fig. 164.—*Camellia drupifera*, a kind of tea

Fig. 165—Sal (*Shorea robusta*)
f, Fruit. *w*, Winged persistent calyx.

represented in Bengal by **sal** (*Shorea robusta*), a gigantic timber tree of great value, with its fruits enclosed within the persistent calyx, three segments of which grow into big wings and two into smaller wings (which help the dispersion of the fruits) (fig. 165)—it yields a resin known as **dhoona**, much used as an incense; and **garjan** trees of Chittagong and Tipperah, which belong to the genus *Dipterocarpus*, the stems of which are tapped for garjan-oil, a liquid balsam or resin much used as a varnish. In the genus *Diptero-*

carpus two of the sepals enclosing the fruit enlarge into two wings, hence the name. A dark-coloured, thick, strong-smelling balsam called **chooa** is obtained by distilling the amber-coloured resin which exudes from wounds in the bark of *Isauxis lanceæfolia* King, a tree that grows in Chittagong (**mohal**). Copal varnish is the resin of *Vateria indica* of South India.

Nat. Order 24. *Malvaceæ*.—Herbs, shrubs, or trees, inner bark fibrous, juice usually mucilaginous. Leaves alternate, simple, palmi-nerved at least at the base. Stipules 2, lateral, free. Flowers regular, usually with a whorl of bracts or epicalyx at the base, forming a sort of exterior calyx. Sepals 5, gamosepalous, lobes valvate. Petals 5, adnate below to the staminal column, imbricate, twisted. Stamens many, monadelphous, the column of stamens being adnate to the claws of the petals at the base. Ovary of 5 to many carpels, syncarpous; style single, passing through the middle of the hollow staminal column and dividing at the top into as many branches as there are carpels, each branch ending in a stigma; ovules 1 to many in each cell. Fruit of dry indehiscent cocci, or capsular. Seeds round or reniform, with scanty mucilaginous albumen.

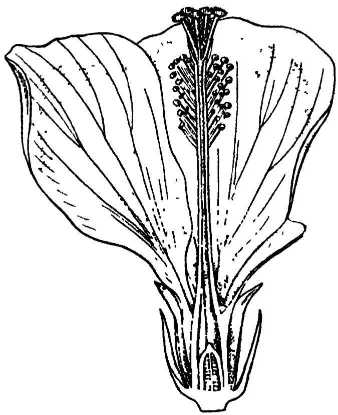


Fig. 166.—Longitudinal Section of Flower of Jaba (*Hibiscus Rosa-sinensis*)

The Order is chiefly distributed in temperate and tropical regions. Common Indian genera are *Sida*, *Abutilon*, *Urena*, *Hibiscus*, *Gossypium*, and *Bombax*.

The following are commonly-occurring plants: **jaba** or Chinese Rose (*Hibiscus Rosa-sinensis*) (fig. 166), a common garden shrub; **bhendi** or **dhanrhas** or Lady's Finger or Ram's Horn (*H. esculentus*), a common cultivated vegetable; **ban-kapas** (*H. vitifolius*); Madras Hemp or Madras **pat** (*H. cannabinus*), which yields a valuable fibre; **sthal-padma** (*H. mutabilis*), the petals

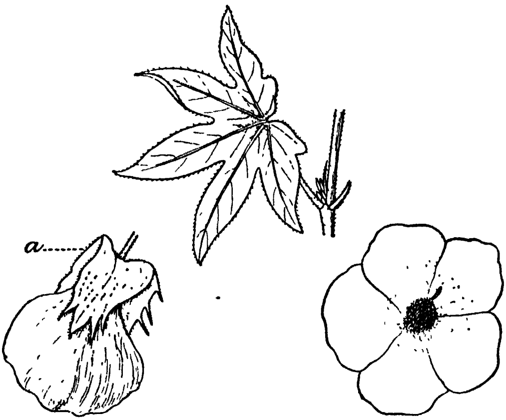


Fig. 167.—Kapas (*Gossypium herbaceum*)

a, Epicalyx.

of which change from white to red in the course of a day; *H. radiatus*, a prickly shrub found in cultivation; **ban-okra** (*Urena lobata*), a common roadside weed with bristly fruits helpful for dispersion; **petari** or **jhumka** (*Abutilon indicum*); **kapas** or **kapas-toola** (*Gossypium herbaceum*) (fig. 167), the hairs on the seeds of which yield the cotton of commerce; **shimool** or Red-cotton tree or Silk-cotton tree (*Bombax malabaricum*), the seeds of which yield stuffing-cotton; and **swet-shimool** or White-cotton tree or Kapok (*Eriodendron anfractuosum*). In the last two plants

the leaves are digitate (see fig. 42) and the stamens are grouped into a number of bundles, a point in which they deviate from the usually monadelphous character of the Order.

The Silk-cotton tree sheds its leaves before flowering, and the big scarlet-red flowers which they put forth, and which are visible from a great distance, attract birds such as crows and **mainas**, whereby pollination is effected. Both the Red- and White-cotton trees put forth large leaves during the monsoon, so that transpiration and hence growth go on very actively. In other words, they exhibit hygrophytic characters during the monsoon. In the dry season, however, they shed their leaves, so that transpiration is reduced and growth slackens. In other words, they exhibit xerophytic characters during the dry season. Plants like these, which can adapt themselves to changes of season, are known as TROPOPHYTES.

Most of the *Malvaceæ* are protandrous and allogamous. The brightly-coloured petals and stigmas render the flowers conspicuous.

Nat. Order 25. *Sterculiaceæ.* — Trees or shrubs, rarely climbing, inner bark fibrous, juice mucilaginous. Leaves and stipules as in *Malvaceæ.* Flowers regular, hermaphrodite, sometimes unisexual; sepals and petals as in *Malvaceæ*, occasionally petals 0; stamens definite, monadelphous, occasionally free, anthers often with intervening staminodia; ovary of 2 to 5 connate carpels, often stalked; style 1 to 5, ovules few or many in each cell; fruits dry or fleshy, dehiscent or indehiscent. Seeds sometimes arillate with fleshy scanty albumen.

Abundant in the tropics. The common plants are **jungli-badam** (*Sterculia fœtida*), a pretty, large tree,

planted on roadsides, with racemose unisexual flowers of dull orange colour. *S. Roxburghii* is a tree of East Bengal, rendered conspicuous by its bright-red calyx (Plate V, fig. B); **sundri** (*Heritiera minor* Roxb.), the tree from which the Sunderban takes its name, and which supplies the best firewood of Calcutta; **mooch-kunda** or **kanak-champa** (*Pterospermum acerifolium*), with its long white odorous hermaphrodite flowers and long fleshy sepals, the smell of which is supposed to kill bugs; **ulat-kambal** (*Abroma augusta*), the mucilage of the roots of which is said to have curative properties in certain female diseases; and *Helicteres Isora* (**antmara**), the follicles of which on dehiscing twist spirally and thus expel the seeds. Cocoa and chocolate are prepared from the seeds of *Theobroma Cacao*, an American plant, which is now largely cultivated in Ceylon.

Nat. Order 26. *Tiliaceæ.*—Trees or shrubs, rarely herbs, inner bark fibrous, juice often mucilaginous. Leaves and stipules as in the two preceding Orders. Flowers regular, cymose. Sepals 5, connate or free, lobes valvate. Petals 5, imbricate. Stamens many, usually inserted on a disk, filaments free or polyadelphous. Ovary of 2 to 5 carpels, connate, 2- to 10-celled; ovules 1 or more in each cell. Fruit fleshy or dry, dehiscent or indehiscent. Seeds with scanty albumen.

Tiliaceæ abound in the tropics. Common plants are **pat** or **koshta** (*Corchorus capsularis* and *C. olitorius*), the bark of which yields jute, the well-known fibre of commerce; *C. acutangulus* (fig. 168), a weed of waste places, the dried leaves of which are used as a stomachic under the name of **nalte-pata**; **phalsa** (*Grewia asiatica*) (fig. 169), a tree planted for its edible berries; **rudraksha** (*Elæocarpus Ganitrus*), the stones of which

are often strung together as beads. In the Lime-tree (*Tilia europæa*) of Europe the inflorescence arises

Fig. 168. – Nalte-pata (*Corchorus acutangulus*)

s s, Lateral stipules.

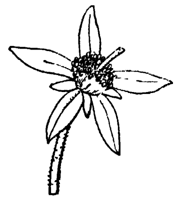


Fig. 169. – Phalsa (*Grewia asiatica*)

from the middle of the upper surface of the leafy bract. Compare this with the inflorescence of the Darjiling plant *Helwingia himalaica* (see fig. 198).

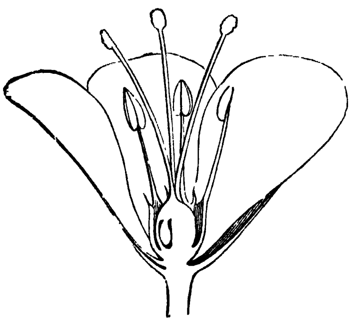


Fig. 170.—Vertical Section of the Flower of *Linum*

Nat. Order 27. *Linaceæ.*—Herbs or shrubs. Leaves alternate, simple, exstipulate. Flowers 5-merous, stamens free, styles free, capsules many-celled, many-seeded.

Chiefly known for the oil yielded by **tishi** or **mashina** or Flax (*Linum usitatissimum*), for which it is largely cultivated in India (figs. 170, 171). In Europe it is chiefly cultivated for the fine fibre yielded by the bark, which is woven into cloth known as linen or **chhalti.**

This Order is characterized by several dimorphic species. Closely allied to it is *Erythroxylaceæ*, a small Order of South America and West Indies.

Nat. Order 28. *Malpighiaceæ*.—Climbing shrubs with opposite entire leaves, petals clawed, stamens usually 10, carpels 3, syncarpous. Fruits samara.

In this large American Order are the gigantic climbers or lianas of the moist forests of South America. It is represented in India by **madhabilata** (*Hiptage Madablota*), a stout woody climber with fragrant bee-flowers and three-winged fruits (samara). The anomalous structure of its wood is characteristic of woody climbers.

Fig. 171. Flax Flowers (*Linum usitatissimum*)

Nat. Order 29. *Geraniaceæ*.—Herbs, rarely shrubs or trees. Leaves either simple, occasionally peltate, or compound, often sensitive, stipules usually 2. Flowers regular or irregular. Sepals 5, connate or free, the upper sometimes spurred. Petals 5, imbricate, stamens as many as, or double or treble, the number of petals, filaments free or connate below. Ovary of 3 to 5 connate carpels, 3- to 5-lobed, produced upwards with the thalamus or axis into a style-bearing beak, or with the styles free or partially connate. Fruit capsular or baccate; when capsular the valves often separate elastically (see fig. 127), and thereby cast the seeds to a distance. Seeds often solitary, albumen scanty or 0.

The plants of this Order grow chiefly in temperate climates. The common plants are **amrul** (*Oxalis corniculata*) (see fig. 50), with its ternate somewhat

sensitive leaves forming a leaf-mosaic, and bright-yellow flowers which remain closed in bad weather, fertilizing themselves cleistogamously; **kamranga** (*Averrhoa Carambola*), a tree with sensitive leaves and five-angular exceedingly acid fruits, and often trimorphic flowers; **dopati** (*Impatiens Balsamina*), a herb cultivated in gardens for its showy often variegated flowers—the capsules (see fig. 79) of it dehisce elastically expelling the seeds to a distance, and the valves twist upon themselves like a corkscrew; **ban-narenga** or **lak-chana** (*Biophytum sensitivum*), a common weed on roadsides, with a rosette of sensitive pinnate leaves and dimorphic flowers (the flowers of all *Biophytum* are as a rule dimorphic); *Hydrocera triflora*, a common water-weed with fistular floating stem; *Pelargonium* or Garden Geranium, a common garden herb grown for its handsome spurred flowers; Garden Nasturtium (*Tropæolum majus*), a trailing as well as twining herb of gardens, climbing by twisting its petiole round the support, with glabrous round peltate leaves, and orange-red large spurred protandrous bee-flowers provided with nectar-guides. When the flower opens, the stamens are seen curving downwards with the anthers still unripe, the style still short, and the stigma closely apposed. The stamens as they mature become erect one by one, shed their pollen-grains exactly opposite the flower entrance, and then again curve downwards. The style in the meantime becomes so long that the mature stigmas take up the position previously occupied by the dehiscing anthers. An insect visiting first a young flower and then an older one will necessarily transfer the pollen of the first flower to the stigma of the latter. The leaves of this plant have water-pores in their margin (see fig. 43). Compare in this respect

the leaves of Bamboo and **kachu** (*Colocasia*). The *Geraniaceæ* are mostly entomophilous.

Nat. Order 30. *Rutaceæ*.—Trees or shrubs, rarely herbs. Leaves abound in pellucid glands filled with essential oil, simple or compound, exstipulate. Flowers regular. Sepals 4 to 5, imbricate, free or

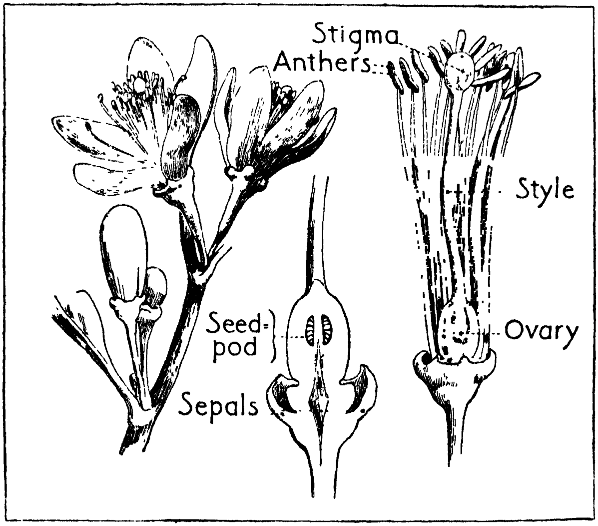


Fig. 172.—An Orange Flower and its Parts

connate. Petals 4 to 5, imbricate or valvate. Stamens 4 or 5 to 8 or 10, rarely more, filaments free, sometimes polyadelphous. Ovary on a disk, composed of 4 to 5 carpels, sometimes more, connate; styles as many as the carpels or connate. Fruit of 1 to 4 cocci, or capsular, or drupaceous, or berry-like (baccate). Seeds with scanty albumen or 0.

It is an Order largely tropical and extra-tropical. The common plants are the different kinds of **nebu** or Orange (fig. 172), or Lemon, or Lime (*Citrus*

medica, *C. Aurantium*, and *C. decumana* or **batabi-nebu**), usually characterized by winged and jointed petioles (see fig. 29 (4)); **bael** or Wood-apple (*Ægle Marmelos*), **kath-bael** or Elephant-apple (*Feronia Elephantum*), **kamini-phul** (*Murraya exotica*), and **ash-shaorha** (*Glycosmis pentaphylla*). The twigs of the last-named plant are largely used as a kind of tooth-brush all over northern India. *Todalia aculeata* (fig. 173) is a shrub found in Orissa and Khasi Hills, armed with peculiar spines. The seeds of **nebu** are often poly-embryonic.

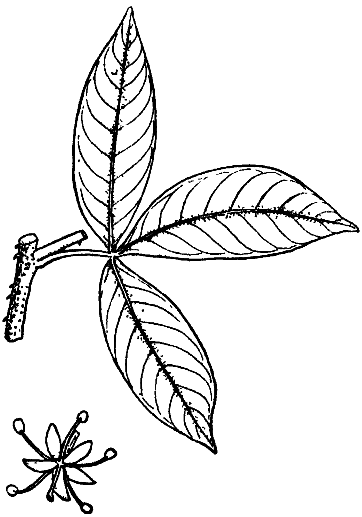


Fig. 173.—Kada todali (*Todalia aculeata*)

Nat. Order 31. *Meliaceæ*. — Trees or shrubs. Leaves alternate, usually pinnate, leaflets generally oblique at the base. Stipules 0. Flowers regular, hermaphrodite or polygamo-diœcious. Disk annular or tubular. Calyx gamosepalous, entire, or 3- to 6-lobed. Petals 3 to 6. Stamens 4 to 12, the filaments cohering to form a columnar tube, at the mouth of which are inserted the anthers, rarely free. Ovary 3- to 5-celled. Fruit various. Seeds, with or without albumen, sometimes arillate.

The Order is mostly tropical. The common plants are **ghorha-neem** (*Melia Azedarach*), common or smaller **neem** (*Melia Azadirachta*), **toon** (*Cedrela

Toona) with winged seeds, Indian Satin-wood (*Chloroxylon Swietenia*) also with winged seeds, and the Mahogany tree (*Swietenia Mahagoni*) imported from Honduras.

Nat. Order 32. *Rhamnaceæ.*—Trees or shrubs, often spinous. Leaves simple. Stipules small, deciduous, or, if persistent, spinous. Flowers regular, hermaphrodite or polygamous. Disk filling the calyx-tube. Sepals connate as a 5-fid calyx. Petals 4 to 5, usually clawed and horned. Stamens 4 to 5, opposite to petals. Ovary usually 3-celled. Fruit various, sometimes samaroid. Seeds with or without albumen.

The Order is abundant in tropical and temperate regions. Common plants are **kul** (*Zizyphus Jujuba*) and **shia-kul** (*Z. Œnoplia*). *Gouania leptostachya* is a climber with inferior three-winged fruits. Inconspicuous protandrous flowers with exposed nectar characterize the Order. Diœcism frequent, dimorphism occasional.

Nat. Order 33. *Ampelideæ* or *Vitaceæ.*—Shrubs, usually climbing by leaf-opposed tendrils. Leaves alternate, simple or digitate, rarely pinnate, petioles thickened at the articulated base and often expanded in a membranous stipule. Flowers small, greenish, sometimes unisexual. Disk prominent. Sepals connate, 4- to 5-toothed or entire. Petals 4 to 5, sometimes connate, caducous. Stamens 4 to 5, opposite the petals. Ovary 2- to 6-locular, partially sunk in the disk; ovules 1 to 2 in each cell. Fruit baccate; seeds with cartilaginous albumen.

The Order is mostly tropical and sub-tropical. Common plants are **harhjorha** (*Vitis quadrangularis*), with jointed quadrangular herbaceous sympodial stem, which climbs by tendrils; **goale-lata** (*Vitis pedata*)

(fig. 174); smaller **goale-lata** (*Vitis setosa*), the herbaceous leaves of which, roasted and oiled, are applied to tumours to bring about suppuration; *Vitis repanda*, a large climber without tendrils; and **dhol-samudra** or **hatikan** (*Leea macrophylla*), a herb with the lower leaves about 2 feet across and the upper ones ½ to 1 foot across, without tendrils. The Grape Vines (*Vitis vinifera*) belong to this family. The flowers of this order are mostly small, greenish, homogamous, and autogamous. Their fragrance, however, indicates the possibility of cross-pollination by insects.

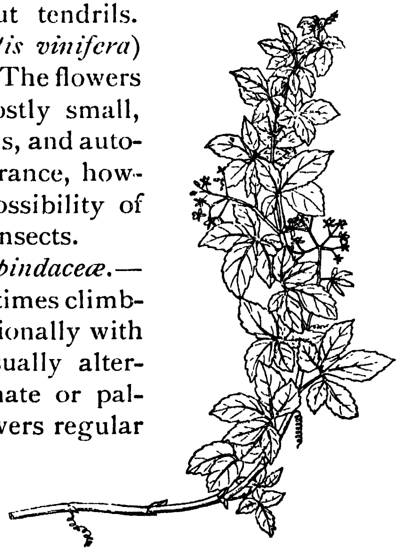


Fig. 174.—*Vitis*, a kind of goale-lata

Nat. Order 34. *Sapindaceæ.*—Trees or shrubs, sometimes climbing by twining, occasionally with tendrils. Leaves usually alternate, compound pinnate or palmate, or simple. Flowers regular or irregular, usually polygamous, small. Disk annular or oblique; sepals usually 4 to 5, free or connate, often unequal. Petals usually 5, occasionally 4, often bearded, with a basal scale. Stamens 5 to 10, free. Ovary 1- to 4-locular, lobed or entire. Fruit capsular or baccate. Seeds with or without aril, albumen rarely present.

The Order is specially abundant in the tropics. Common plants are **ritha** or Soap-nut (*Sapindus trifoliatus* and *S. Mukorossi*), the fruits of which make a soap-like lather in water, and are largely used for washing silk and woollen fabrics, which are spoiled by mineral

soaps; **lichoo** or Litchi (*Nephelium Litchi*) and **ans-phal** (*N. Longana*), the seeds of both are wholly covered with abundant edible aril; and **shib-jhul** (*Cardiospermum Halicacabum*) (see fig. 61), a common weed climbing by tendrils, a pair of which is formed by the modified pedicles at the lowest portion of each raceme, and having a 3-celled inflated ovary, with one seed in each cell, each seed with a small white cordate aril at its base. The saponaceous principle present in many species has given the name to the Order. *Allophyllus Cobbe* (fig. 175) is a small tree or shrub often met with in hedges. The Sugar Maple (*Acer saccharinum*) is a North American plant well known for its sugar-yielding juice. *Acer oblongum* is a tree often grown in northern India on roadsides, and easily known by its 2-winged fruits.

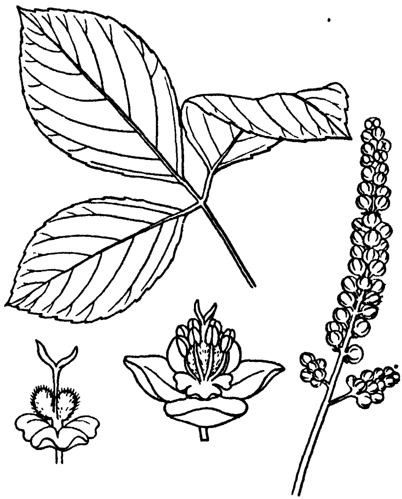


Fig. 175.—*Allophyllus Cobbe*

Nat. Order 35. *Anacardiaceæ*.—Trees or shrubs, often with resinous juice. Leaves usually alternate, simple or compound. Flowers regular, small, sometimes polygamous or unisexual. Sepals 3 to 5, connate, petals 3 to 5, rarely 0. Stamens as many as the petals, free. Carpels solitary or 2, connate, ovary 1-celled, rarely 2- to 5-celled. Fruit usually 1-celled,

1-seeded, or 2- to 5-celled and 2- to 5-seeded drupe. Seeds exalbuminous, embryo large, with fleshy cotyledons.

The Order is chiefly tropical. Common plants are **am** or Mango (*Mangifera indica*), with polygamous 1-staminate flowers in terminal panicles; **bhala** or Marking-nut (*Semecarpus Anacardium*), a fruit with a roundish nut on the top of a pyriform fleshy peduncle (fig. 176), used by washermen to mark clothes; **hijli-badam** or Cashew-nut (*Anacardium occidentale*) (see fig. 131), with a kidney-shaped nut seated on a pyriform fleshy peduncle (the kernel of the nut is eaten as a kind of **badam** or Almond, and the peduncle is eaten in acid curries); **amrha** or Hog-plum (*Spondias mangifera*); **belati-amrha** (*S. dulcis*); and **jiyal** or **jiuli** (*Odina Wodier*). *Rhus khasiana* is a commonly growing tree in Chittagong and Shillong with compound pinnate leaves which give the tree the appearance of a **neem** (*Melia*) tree.

Fig. 176.—Fruit of Bhala (*Semecarpus Anacardium*)

Sub-class 2. CALYCIFLORÆ

Nat. Order 1. *Leguminosæ*.—Herbs, shrubs, or trees. Leaves alternate, usually pinnate, rarely simple (*Bauhinia*). Stipules 2, free; leaflets often with secondary stipules or stipels. Flowers regular or irregular. Carpel 1, superior, 1-celled; ovules usually several, 2-seriate, anatropous. Fruit usually a legume (pod), less often a lomentum. Seeds exalbuminous with fleshy or leafy cotyledons.

This is one of the most cosmopolitan families of plants, and the second largest, containing between

6000 and 7000 species. Because it is a very large Order it is divided into three Sub-Orders, of which the first is cosmopolitan and the other two are tropical and extra-tropical.

Sub-order 1. *Papilionaceæ.*—Flowers irregular. Corolla papilionaceous or vexillary. Stamens usually 10, diadelphous (9 + 1), that is, 9 form one bundle, situated anteriorly, and 1 remains free, situated posteriorly (see fig. 97) in the cleft on the upper side of the bundle, occasionally monadelphous. Most of the climbing *Papilionaceæ* are twiners. The brightly-coloured papilionaceous flowers are often clustered together into very conspicuous inflorescences admirably adapted to attract insects, especially bees. The ample pendulous racemes of *Amherstia nobilis*, often planted, are the most showy of the *Papilionaceæ*. Fragrance often adds to their attraction. The vexillum covers and protects the inner parts in unopened flowers and acts as a signboard in the open ones, and often has nectar-guides. The alæ are the resting-places for the visitors, and act as levers depressing the keel during insect-visits, so that the stigma and anthers, which are kept hidden within the keel, are exposed and brought into contact with the under sides of the visitors. After the departure of the visitors the alæ rise and the keel regains its place with regard to the stigma and anthers. The keel is also protective, sheltering the stigmas and pistil from rain and unbidden guests. The ovary is enveloped by the sheath of filaments, and the curved-up bearded style with the stigma projects beyond the anthers, so that the stigma first projects out of the keel when an insect visits the flower and first touches its belly. A bee visiting different flowers of the same species thus brings about cross-pollination. The pair of slits by

the side of the posterior single filament leads to the nectar secreted inside the base of the stamens.

The **dal** or Pulses, which form important food-grains all over India, belong to this sub-order, namely, **chhola** or **boot** (*Cicer arietinum*); **masur** or Lentil (*Lens esculenta*); **matar** or Pea (*Pisum sativum*, *P. arvense*); **arhahar** (*Cajanus indicus*); **sona-moog**, **kala-moog**, **ghora-moog**, **mash-kalai**, &c., which are different species or varieties of *Phaseolus*; **khesari** (*Lathyrus sativus*); **jungli matar** (*L. Aphaca*), with the whole leaf converted into a tendril and stipules foliaceous (fig. 177). Besides the Pulses, the pods of **barbati** (*Vigna Catjang*), **shim** (*Dolichos Lablab*), **makham-shim** (*Canavalia ensiformis*), and Bean (*Vicia Faba*) are common table vegetables; **ban-barbati** (*Phaseolus adenanthus*) is common though not cultivated; Ground-nut or **chiner-badam** or **mat-kalai** (*Arachis hypogæa*) is cultivated for the fruits which droop down and are forced under the ground by the elongation and twisting of the peduncle and ripen there. The seeds are eaten as **badam** either roasted or not, and also yield oil, for which it is cultivated in the Madras Presidency. The tuberous roots of **sank-aloo** (*Pachyrhizus angulatus*) are eaten raw, and taste as a sweet fruit. The bast fibres of **shone**

Fig. 177.—Jungli matar (*Lathyrus Aphaca*)

(*Crotolaria juncea*) are used in making ropes, &c., which are more lasting than those made of **pat** or Jute. The well-known dye, indigo, is yielded by **nil** (*Indigofera sumatrana*). The valuable timber **shishoo** is obtained from the **shishoo** tree (*Dalbergia Sissoo*). The stems of **shola** (*Æschynomene aspera*), a water-plant, are used as a substitute for cork, as floats for fishermen, and for various ornamental purposes; the leaves of it are somewhat sensitive. The leaves of *Smithia ciliata*, a common herb of the Pareshnath Hills, are also sensitive. The red seeds of **kunch** (*Abrus precatorius*) are used as small weights by jewellers. The flowers of **palte-madar** (*Erythrina indica*), **apara-jita** (*Clitoria Ternatea*), **bak-phul** (*Sesbania grandiflora*), and **palash** (*Butea frondosa*) are very showy; the first and third are ornithophilous or bird-pollinated and the last entomophilous. The first is also a good example of a tropophyte. The automatic or nutation movement of the two lateral leaflets of the trifoliate leaves of the Telegraph-plant, **ban-chandal** or **gora-chand** (*Desmodium gyrans*) (fig. 178), a common weed in waste shady places, is a very interesting phenomenon; **alkushi** (*Mucuna pruriens*) is a climber which is dreaded on account of the stinging hairs which cover its pods. *M. monosperma* is also a kind of **alkushi** of East Bengal (fig. 179).

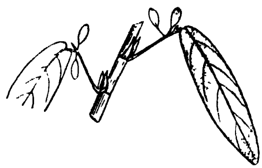


Fig. 178.—Telegraph Plant or Gora chand (*Desmodium gyrans*)

Sub-order 2. *Cæsalpinieæ*.—Flowers slightly irregular. Petals 5, unequal, imbricate, the upper one inside and enclosed by the others. Stamens usually 10, free, some often abortive.

The common plants are **sondal** or Indian Labur-

num (*Cassia Fistula*), a big tree with long pendulous racemes of bright-yellow flowers and rod-shaped indehiscent legumes, the pulp of which is used as a purgative; **kal-kasonda** or **chakunda** (*Cassia occidentalis*, *C. Sophera*, *C. Tora*), common shrubs on waste lands and roadsides; **kanchan** (*Bauhinia acuminata*, *B. variegata*, *B. purpurea*), trees with deeply emarginate or bilobed simple leaves; **asok** (*Saraca indica*), **tentul** (*Tamarindus indica*), **krishna-chura** (*Cæsalpinia pulcherrima*) (fig. 180), **radha-chura** or Gold Mohar tree (*Poinciana regia*), and **nata** (*Cæsalpinia Bonducella*). The Gold Mohar tree and the Indian Laburnum tree shed their leaves in spring, and the racemes of showy flowers burst forth from leafless branches, presenting an attractive sight from long distances. These trees are ornithophilous.

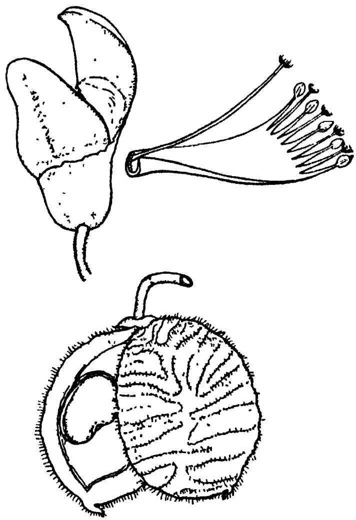


Fig. 179.—*Mucuna monosperma* (a kind of alkushi)

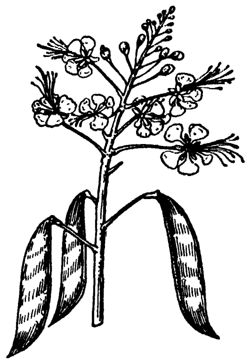


Fig. 180.—Krishna-chura (*Cæsalpinia pulcherrima*)

Sub-order 3. *Mimoseæ.*—Flowers regular, petals hypogynous, valvate. Stamens hypogynous, definite

or indefinite, usually free, sometimes monadelphous.

Common plants are **lajwabati** or Sensitive Plant (*Mimosa pudica*); **pani-lajuk** (*Neptunia oleracea* and *N. plena*) (fig. 181), common water-weeds with sensitive leaves, hence called the **lajwabati** of water, as *Mimosa pudica* is the **lajwabati** of land; **babla** (*Acacia arabica*), **gua-babla** (*A. Farnesiana*), **khair** (*A. Catechu*), **gila** (*Entada Pursætha* D.C.), and **sirish** (*Albizzia Lebbek*).

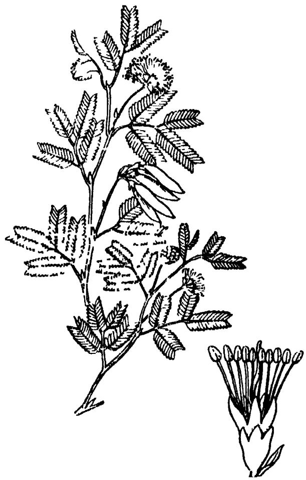


Fig. 181.—Pani-lajuk (*Neptunia*)

The familiar instance of the extreme sensitiveness of the leaves of *Mimosa pudica*, the Sensitive Plant, is an interesting study (see fig. 138). The leaf is pinnate, consisting of a primary axis or petiole, at the end of which are inserted four secondary axes, to which thickly crowded leaflets are attached right and left. The axes, primary and secondary, as well as the leaflets, are articulated by well-developed PULVINI or tumid motile apparatus. In the normal state the primary axis stands obliquely upwards, and the secondary axes with the leaflets are spread almost horizontally. Upon a suitable stimulus or irritation, such as vibration, the leaflets fold upwards and forwards in pairs; then the secondary axes move laterally, so as to come close together and lie almost parallel; and, lastly, the primary axis droops downwards, taking with it the secondary axes. The behaviour of the leaf is still more curious when a

few of the leaflets are touched. For example, if the lowest leaflet of a secondary axis is touched, all the leaflets of that axis fold upwards and forwards rapidly in succession from the base to the apex. The stimulus then proceeds to the next contiguous secondary axis, which closes its leaflets in the same manner, and so on to the third and fourth axes. The four secondary axes then come closer together, and ultimately the primary axis droops downwards. The stimulus, if sufficiently strong, is often communicated to contiguous leaves, which close in the same manner as above. The pulvinus seems to be the motor apparatus. The manner and the rapidity with which the stimulus is conveyed from leaflet to leaflet, from secondary axis to secondary axis, from one leaf to another leaf, is similar in character to the conduction of nervous impulse in animals, so much so that many physiologists are inclined to believe that it is also a kind of nervous impulse conducted in the same way in plants as in animals, although the nervous mechanism has yet to be discovered in plants. Recent researches of Sir J. C. Bose seem to indicate that the sieve-tubes, with the companion cells, are the main channels for the conduction of the nervous impulse in plants.

Sir George Watt thus writes of the Sensitive Plant: "The leaves of the Sensitive Plant close when you touch them, and yet they do not do so when they are made to touch each other by the wind. On the approach of rain, the leaves prepare for a possible storm by closing. If rain comes suddenly, the drops on touching the leaves do not for a time cause them to close, the plant being surprised. If you take a Sensitive Plant (grown in a flower-pot) into your carriage beside you, the leaves will close when the carriage moves, but after a time they will open again

(even though the carriage goes on moving). On your ordering the carriage to stop, the timid leaves, not prepared for so sudden a change, suddenly drop down. Touch the leaf-stalk near the stem upon its under surface and the whole leaf will gradually move down, without the leaflets closing; touch one of the leaflets, and all the leaflets below it will close, while those above will remain expanded."

The pinnate leaves of most of the *Leguminosæ* assume different positions during day and night. The leaflets are spread almost horizontally during the day, to catch as much sunlight as possible; during night the leaflets fold upwards or downwards in pairs, with their upper faces closely approximated. This is known as the "sleep-movement" or NYCTITROPISM. This movement seems, on a closer inspection, to be a protective arrangement against deposit of dew, which would stop evaporation (transpiration), and thus stand in the way of food manufacture. The pulvini mentioned above are the motile organs.

Nat. Order 2. *Rosaceæ.*—Most abundant in temperate regions. The common plants are the various species of **golap** or Rose. The Apple, Pear, Plum, Peach, Apricot, Cherry, Strawberry, Raspberry, &c., well-known fruits of the temperate regions, are imported into Calcutta from Europe and also from the Himalayas. The Loquat or **loquat-phal** of Calcutta (*Eriobotrya japonica*) is a small tree cultivated near Calcutta for its fruit. The hip of the Rose (see fig. 133) is its fruit, consisting of a jug-shaped thalamus lined internally by the minute free carpels, which look like and are mistaken for seeds. It is somewhat similar in structure to the fig, but the fig is the product of an inflorescence, while the hip of the Rose is the product of a single flower. Indian Strawberry (*Fragaria*

nilgerrensis) (fig. 182), a trailing herb common in Shillong, has a globose, pale-pink fruit. Some of the Rosaceæ resemble Ranunculaceæ in the structure of their flowers.

Nat. Order 3. *Crassulaceæ.*—Herbs or under-shrubs. Stems and leaves usually succulent. Leaves usually simple, sometimes lobed. Flowers regular. Sepals 4 to 5, connate, inferior. Petals 4 to 5, free. Stamens as many as, or twice as many as the petals, hypogynous or epipetalous. Carpels 4 to 5, apocarpous. Fruit usually follicular. Seeds albuminous.

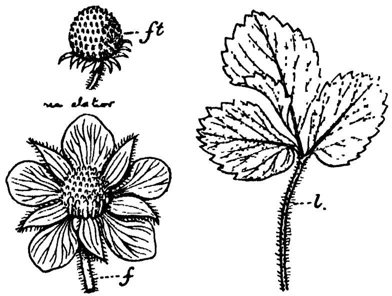


Fig. 182.—Strawberry (*Fragaria nilgerrensis*) *l*, Leaf. *f*, Flower. *ft*, Fruit.

General in the Northern Hemisphere. This Order is characterized by completely isomerous flowers, a peculiarity rather rare among Dicotyledons. The common plants are **pathar-kucha** and **himsagar** (*Bryophyllum calycinum* and *Kalanchoe laciniata* (fig. 183), the former with long tubular pendulous, and the latter with erect, protandrous flowers. Observe that the margins of the leaf of the first are crenate, and that in the crenatures buds arise (see fig. 126). These buds gradually develop into seedlings, which, separating from the leaves, drop to the ground and grow into new plants. When placed in moist soil, the leaves or their fragments also develop seedlings from their crenatures. This is taken as an instance to illustrate the development of ovules from buds borne upon the margins of carpellary leaves (marginal theory of

placentation). The *Crassulaceæ*, with their succulent stems and leaves covered with a thick cuticularized epidermis, are xerophytes. They thrive best in dry and sandy places. Rocks and walls are their favourite seats.

Nat. Order 4. *Droseraceæ.*—Herbs, sometimes aquatic, mostly insectivorous. The representative genera are *Drosera*, *Aldrovanda*.

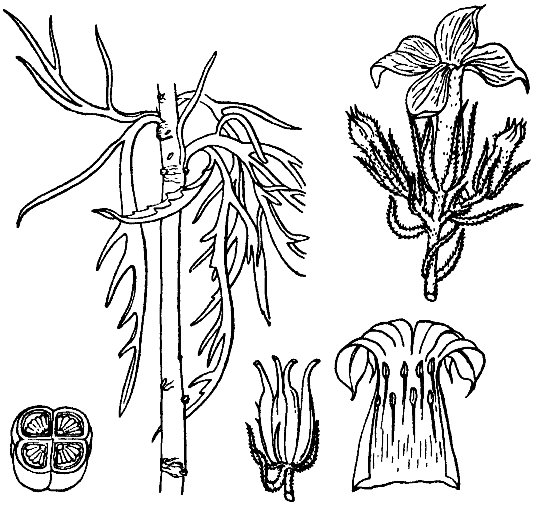


Fig. 183.—Himsagar (*Kalanchoe laciniata*)

In Bengal are found *Drosera Burmanni* (see Plate II, fig. A) and *D. indica*, both of which are small insectivorous herbs with glandular (tentacular) leaves. *Drosera peltata*, var. *lunata* (see Plate II, fig. B) is an insectivorous herb of the Khasi Hills (Shillong). The flowers in these plants are either cleistogamous or pseudo-cleistogamous. *Aldrovanda vesiculosa* (see figs. 68, 69) or Malacca **jhangi**, a common submerged herb of our tanks, also belongs to this

Order. The leaves of these plants as apparatus for entrapping insects have already been described on pp. 67 and 68. The arrangement for self-pollination in Aldrovanda is interesting: the anthers get bound to the stigma by pollen-tubes. Venus's Fly-trap

Fig. 184.—Venus's Fly-trap (*Dionæa muscipula*)

(*Dionæa muscipula*) (fig. 184), a plant of North American bogs, is well known for its sensitive leaves, which, like rat-traps, enclose flies and other insects, and digest them. *Aldrovanda vesiculosa* is the Indian representative of Venus's Fly-trap.

Nat. Order 5. *Haloragaceæ*.—This is a family of water-plants with inferior ovary, and is represented in

Bengal by the genus *Myriophyllum tuberculatum* and *M. indicum*. The former is characterized by floating or submerged stems and highly-dissected submerged leaves, commonly found in the border of the salt lakes and other moist places near Calcutta. The latter is common in tanks.

The submerged leaves of water-plants, like those of *Myriophyllum*, are often deeply indented, with filiform lobes like a bunch of fibrous roots. This is an adaptation to environment, enabling the plants to absorb water with its dissolved carbon dioxide, and oxygen, and mineral matters through the leaves, which being highly cut up, afford a larger surface area for absorption. Moreover, they offer less resistance to the current and turmoil often set up in water, which would tear expanded blades into shreds. Such water-plants have, as a rule, very little or no root system, the function of the latter being taken up by the root-like leaves. Compare the water-plants *Utricularia*, *Aldrovanda*, and *Salvinia* (**ulki-pana** and **indur-kani-pana**) in this respect. Water-plants again have often intercellular cavities and passages filled with air which serve the double purpose of aerating the plants and also buoying them up, so as to prevent them from sinking into the mud by their own weight. Strengthening and conducting tissues, such as sclerenchyma and bundles, are very little developed, as they are not required, and the epidermal cells are thin-walled, as there is no necessity for conserving the water-supply. These are the common characters of aquatic hygrophytes.

Nat. Order 6. *Rhizophoraceæ*. — Trees of salt swamps or marshes, leaves coriaceous, opposite, stipulate (interpetiolar), calyx valvate, petals often fringed, stamens definite, ovary inferior or half-in-

ferior, seeds germinating while the fruits still remain attached to the tree. The Order is well known from the Mangrove trees that grow in the swamps of the Sunderban.

The germination of the seeds is most peculiar (fig. 185). The radicle perforates the apex of the fruit and elongates while the fruit still remains on trees. The elongated radicle is often 1 to 2 feet long, club-shaped, and pointed at the apex. When the radicle is fully developed, the embryo separates from the tree and falls perpendicularly down into the mud below by its own weight, and fixes itself there by its pointed and heavy end. Mangrove trees also produce abundant breathing-roots—an adaptation to their environment. The Mangrove trees belong to the genus *Rhizophora*. *Kandelia*, *Bruguiera*, and *Ceriops* are other common genera of the Sunderban.

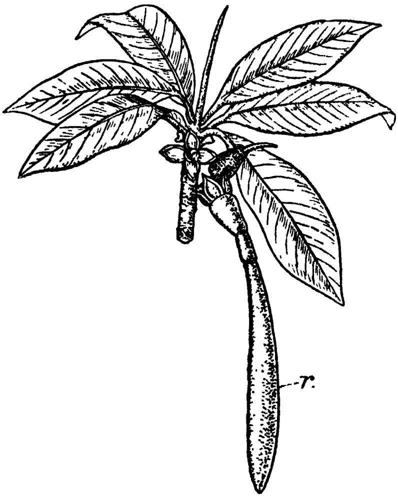


Fig. 185.—Mangrove—Chora (*Rhizophora conjugata*)

r, Radicle growing.

Nat. Order 7. *Combretaceæ*.—Trees or shrubs, often climbing. Leaves usually simple. Flowers polygamo-dioecious or bisexual. Sepals usually connate, in a 4- to 5-lobed superior calyx. Petals usually 4 to 5, epigynous. Stamens 4 to 5 in 1 whorl, or 8 to 10 in

2 whorls inserted on the tube or limbs of the superior calyx. Ovary inferior, 1-celled. Fruit indehiscent, drupaceous or leathery. Seed solitary, exalbuminous. Chiefly tropical. The common plants are **deshi-badam** or Country Almond (*Terminalia Catappa*); the kernel of its nut is edible, and the thick pericarp is full of air-chambers; this makes the fruits light and impervious to water, so that they are disseminated through the agency of running water without any harm to the germinating power of the enclosed seeds. Bats also help in the distribution of the fruits. **Bairha** (*Terminalia belerica*) and **haritaki** or Myrobolan (*Terminalia Chebula*) yield fruits with abundant tannin; **arjun** (*Terminalia Arjuna*) and **ashan** (*Terminalia tomentosa*) are both timber trees with 5-angled fruits; *Anogeissus latifolia* is a big tree of Orissa with a cluster of winged fruits (fig. 186); Rangoon Creeper (*Quisqualis indica* and *Q. malabarica*) is a common ornamental garden climber. In the last species the blades fall off when mature, leaving behind the petioles, which grow into rigid spines.

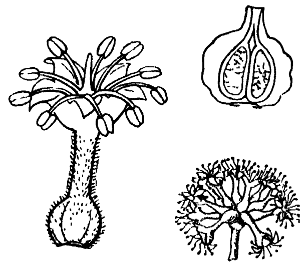


Fig. 186.—Anogeissus latifolia

Nat. Order 8. *Myrtaceæ*.—Trees or shrubs, rarely herbs. Leaves usually opposite, simple, entire, with a sub-marginal vein (see fig. 36), coriaceous, and gland-dotted. Flowers regular. Sepals connate, superior, limbs 4 to 5. Petals epigynous, 4 to 5, imbricate. Stamens numerous, epigynous, free or polyadelphous (*Melaleuca*). Ovary inferior, 1- to 2-celled. Fruit usually tipped by the calyx limbs,

indehiscent and berry-like or capsular. Seeds exalbuminous.

The Order is mainly tropical and sub-tropical. Common plants are **pyara** or Guava (*Psidium Guyava*), **golap-jam** or Rose-apple (*Eugenia Jambos*), **kala-jam**

Fig. 187.—Cloves (labanga) (*Eugenia caryophyllæa*)
1, Inflorescence, 2, Single bud. 3, Section of bud.

(*Eugenia Jambolana*), **jamrool** (*Eugenia malaccensis*), all of which are cultivated for their fruits. Cloves or **labanga** (*Eugenia caryophyllæa*) (fig. 187) is a native of the Malacca Islands, and not indigenous in India but cultivated in southern India and Ceylon; the cloves of commerce are the dried unopened flower-

buds of this plant. *Melaleuca Leucadendron* (fig. 188) is a native of the Malacca Islands. It appears to be the plant from which the Cajuput oil of commerce is chiefly obtained. It has been introduced as a garden plant. Note its many-nerved leaves and innumerable stamens collected into five bundles or groups. Species of the Australian genus *Eucalyptus* are being successfully cultivated all over India, and some of them are gigantic timber trees. Allspice (*Pimenta acris*, Wight), a West Indian tree, is much cultivated for its aromatic berries. The flowers are mostly protandrous and visited by ants and bees.

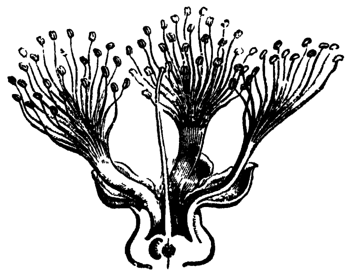


Fig. 188.– Vertical Section of the Flower of *Melaleuca*

Nat. Order 9. *Lythraceæ.*—Trees or shrubs or herbs often with 4-angled branches. Leaves entire, opposite, sometimes whorled. Flowers regular. Sepals connate in a calyx-tube with 3 to 6 lobes, inferior. Petals as many as the calyx-lobes, crumpled in the bud. Stamens few or numerous, perigynous. Ovary superior, 2- to 6-celled. Fruit dehiscent or indehiscent. Seeds numerous, exalbuminous. Mostly tropical.

The common plants are **jarool** (*Lagerstrœmia Flos-Reginæ*), a timber tree; *Lagerstrœmia indica*, a shrub; **mehdi** or Henna or Indian Privet (*Lawsonia alba*), planted specially in hedges: the leaves of this plant are used by the Mohammedans for dyeing their nails and beards red; **dadmari** (*Ammania baccifera*) is a roadside weed; **dalim** or Pomegranate (*Punica Granatum*) has a peculiar fruit which is an

inferior many-celled berry with a hard rind, crowned by the persistent calyx-lobes. On account of the inferior ovary the plant is often classed with the Nat. Order *Myrtaceæ*. The flowers are mostly odourless and nectarless, but conspicuous, and produce abundant pollen-grains (pollen flowers). The Order includes a large number of dimorphic and trimorphic species; for example, **dhain-phul** (*Woodfordia floribunda*), a common shrub with racemes of red flowers, is trimorphic. A few species are also known to bear cleistogamous or pseudo-cleistogamous flowers.

Nat. Order 10. *Onagraceæ*.—Herbs, sometimes aquatic. Leaves opposite or alternate. Flowers regular and almost always 4-merous. Sepals superior, in a connate calyx with usually 4 limbs, imbricate. Petals usually 4, epigynous. Stamens 1 to 8, epigynous. Ovary inferior, 1- to 6-celled, most commonly 4-celled. Fruit capsular or nut-like or berry. Seeds exalbuminous.

The Order is most abundant in the North Temperate Zone. Common plants are **paniphal** or **singarha** or Water Chestnut (*Trapa bispinosa*), a floating herb with submerged leaves pinnatipartite and root-like, and floating leaves large and rhomboidal, petiole with a spongy swelling at its apex to serve as a float, and large ovoid 4-angled nuts, all or only 2 angles of which are spinous; observe how the structure of the plant is adapted to its aquatic habit; **kesar-dam** (*Jussiæa repens*), a common herb partly creeping in the mud and partly floating on the surface of tanks by the help of spongy swellings at the nodes; **ban-labanga** (*Jussiæa suffruticosa*), an erect herb with square stems of moist places. *Ludwigia prostrata* is a prostrate herb and *L. parviflora* an erect weed (fig. 189) of rice-fields. In the garden species of the orna-

PLATE V

A. *Osbeckia Chinensis*

B. *Sterculia Roxburghii* (Ushli)

Ca, scarlet calyx

mental South American genus *Fuchsia*, with handsome nodding flowers, the perianth is beautifully coloured, and from it is extracted *fuchsine*, a red colouring matter much used as a staining reagent.

The flowers of *Trapa* expand about an hour before sunrise and remain open only a few hours after sunrise. These are pseudo-cleistogamous. Besides these there are submerged true cleistogamous flowers.

Fig. 189.—*Ludwigia parviflora*

ov, Inferior ovary

Nat. Order 11. *Melastomaceæ.*—Herbs or shrubs, with opposite entire, curvi-veined, simple, beautifully-shaped leaves, which are very characteristic. Stamens definite, with beaked anthers opening by pores at the apex. Ovary inferior or half-inferior. Fruit usually in the form of a cup or jug.

The Order is mostly tropical. It is hardly met with in the plains of Bengal excepting in the Sunderban, but is common in hilly places, as Khasi Hills, Darjiling, and Pareshnath Hills. *Melastoma* (fig. 190), *Sonerila*, and *Osbeckia* (Plate V, fig. A) are representative genera.

Nat. Order 12. *Cucurbitaceæ.*—Climbing or creep-

ing herbs or shrubs. Tendrils solitary, usually extra-axillary, simple or branched. Leaves simple, alternate, palmi-veined, frequently cordate at the base, and lobed. Flowers monœcious, or less commonly diœcious, yellow or white. Calyx campanulate or tubular, lobes usually 5, imbricate. Petals 5, inserted on the calyx-tube, sometimes gamopetalous (exceptional among *Calyciflorœ*). Stamens of 5 filaments, 2 pairs of which unite to form 2 filaments, and 1 free, forming altogether 3 free filaments. Anthers free or syngenesious, one usually 1-celled and the other two 2-celled each. Lobes straight or sinuous (fig. 191), that is, twisted up and down like the letter ᔕ. Ovary inferior, composed of 3 carpels, syncarpous, the united margins of the carpellary leaves first turn inwards towards the centre, and then reflex outwards, so that the placentas become parietal (fig. 192). Style 1, with 3 stigmas. Ovules many, in two series on the

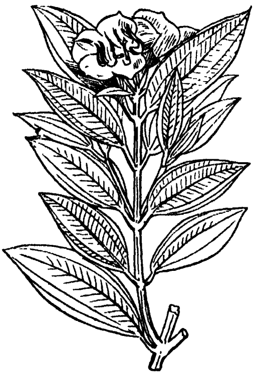


Fig. 190.—Melastoma malabathricum

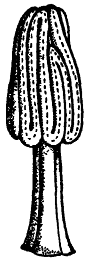


Fig. 191.—Sinuous Anther

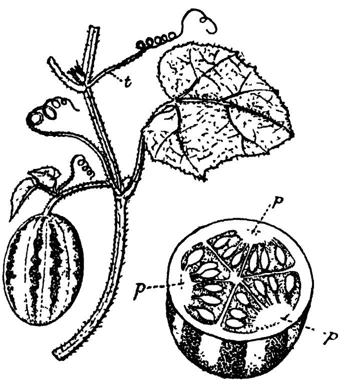


Fig. 192.—Cucumis

t, Extra-axillary tendrils. *p*, Parietal placenta.

3 parietal placentas. Fruit usually a berry or opening circumcissilely (*Luffa ægyptiaca*) or by valves (*Momordica Charantia*). Mostly tropical.

Common plants are **shasha** or **khira** or Cucumber (*Cucumis sativus*), **kankur** or **kharbuza** or **phuti** or Melon (*Cucumis Melo*) (fig. 192), **tarmuz** or Water Melon (*Citrullus vulgaris*), **patal** or Palwal (*Trichosanthes dioica*), **chichinga** or **hopa** or Snake-gourd (*Trichosanthes anguina*), **makal** (*Trichosanthes palmata*), **jhinga** (*Luffa acutangula*), **dhundul** (*Luffa ægyptiaca*), **chal-kumrha** or **deshi-kumrha** (*Benincasa cerifera*), **belati-kumrha** or Gourd or Sweet Marrow (*Cucurbita maxima*), **uchhe** and **karala** (*Momordica Charantia*), **kakrole** (*M. cochinchinensis*), Bottle-gourd or **lau** or **kadoo** (*Lagenaria vulgaris*), **tela kucha** (*Cephalandra indica*), which bears deep-red globular fruits much eaten by parrots and crows. Notice that although the Order is *Calycifloral*, the corolla is in some species gamopetalous, as in *Corollifloræ* or *Gamopetalæ*.

When **shasha** is in flower, the plant is visited by a reddish-yellow fly known as a lady-bird. These insects fly about from flower to flower to feed on the honey secreted within the corolla-tube, and thus carry the pollen-grains from the male flowers to the stigma of the female flowers. Note also how the yellow flowers of **jhinga** open towards the evening and close again next morning (pseudo-cleistogamous), and how they are visited by small midges, which no doubt pollinate the flowers. The plants of this order, which have broad, thin, glabrous leaves, are hygrophytes, and flourish during the rains. Those with thick, hairy, and often divided leaves are xerophytes, and flourish in sandy soils during summer. Some which can accommodate themselves to change of

environments are tropophytes, as, for instance, **shasha**.

The male flowers are larger than the female flowers, so that the insects pay their first visits to the former. Ants and flies are active pollinators.

Nat. Order 13. *Passifloraceæ*.—Closely allied to

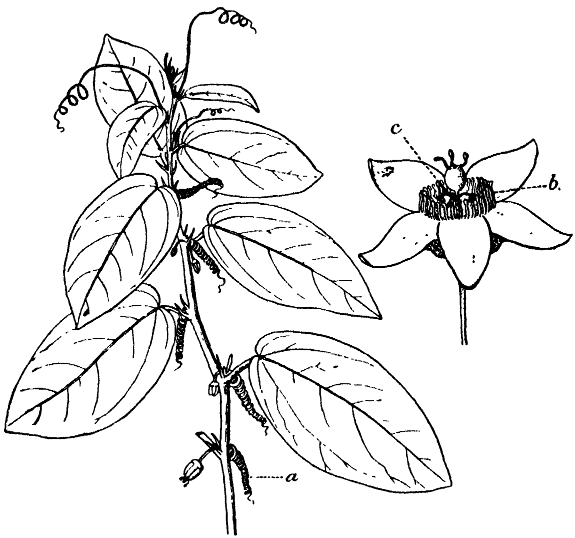


Fig. 193.—A kind of jhumka (*Passiflora suberosa*, Linn.) showing *a*, axillary tendril; *b*, corona; *c*, gynandrophore.

Cucurbitaceæ in habit, but differing from it in having hermaphrodite flowers, superior ovary, 1-celled, with 3 parietal placentas, and beautiful corona of filiform appendages arising from the tube of the perianth. It is represented in our gardens by the showy climber **jhumka-lata** or Passion flower (*Passiflora fœtida*, Linn.), an American plant naturalized in India, and *P. suberosa*, Linn. (fig. 193); the tendrils are axillary. The Papaw or **panpe** (*Carica Papaya*) is also a native

of America naturalized in India. The milky juice of the unripe fruit possesses a digestive property, and is often used to make meat tender while cooking. It is a diœcious plant, often rendered monœcious during cultivation. If a male plant is pollarded it often puts forth new heads which bear female flowers and fruits.

Nat. Order 14. *Begoniaceæ*.—It is represented by the genus *Begonia*, which is found in gardens only in the plains of Bengal. *Begonias* are usually succulent herbs, with mostly oblique leaves and epigynous unisexual flowers, with indefinite stamens. The leaves or fragments of them when planted produce buds which ultimately give rise to plants. Compare with this the buds of **pathar-kucha** and **himsagar.** The plants of this order are mostly xerophytes. Two common species in Chhota Nagpur and Sylhet respectively are *Begonia picta* and *B. barbata*.

Nat. Order 15. *Cactaceæ*.—Herbs, shrubs, or trees, with thick, globular or columnar, or flattened and jointed, or many-angled stems. Leaves usually reduced to tufts of spines or prickles or small tubercles. Flowers regular, hermaphrodite, epigynous, and solitary; sepals, petals, and stamens numerous and acyclic. Carpels numerous, ovary inferior, 1-celled, placentas many, parietal. Fruit a berry. Seeds exalbuminous.

This is an order mostly confined to America. Prickly Pear or **nag-phani** or **phani-monsha** (*Opuntia Dillenii*) (see fig. 26) is an American plant naturalized in India. Notice the gradual transition from bracts through sepals to petals. It is well known for its flattened, spinous, jointed, green stems, and is much used as a hedge plant. The absence of leaves and the presence of thick epidermis and hard, thick-set spines are adaptations for the storage and conservation of water necessary in dry sandy situations in which the

plant grows. In other words, it is a typical xerophyte. The spines also form a very effective defensive armature. Many *Euphorbias* have the habit of the *Cactus*, with which they are often confounded. In South India a *Cactus* has been naturalized known by the name of *Cereus grandiflorus*, which bears showy flowers, opening at night and adapted for pollination by night-roving insects.

Fig. 194.- *Bupleurum mucronatum.* Fruit bursting into two halves or mericarps (*mc.*), hanging from two-forked carpophore *c.*

The spines are mostly modified shoots; the plants are mostly xerophytes, some are epiphytic.

Closely allied to it is the Order *Ficoideæ*, which are succulent herbs or shrubs with opposite simple leaves and flowers with numerous stamens and inferior many-celled ovary. The Ice-plant (*Mesembryanthemum crystallinum*) is so called because of the water vesicles on the epidermis, which sparkle in the sun like crystals of ice.

Nat. Order 16. *Umbelliferæ.*—Herbs, rarely shrubs. Stem usually fistular. Leaves alternate, usually dissected; petiole usually sheathing at the base. Flowers usually regular, in compound rarely simple umbels. Sepals connate in a superior calyx, limb 5-toothed. Petals 5, epigynous, often unequal. Stamens 5, epigynous. Ovary inferior, 2-celled, crowned by a 2-lobed disk; styles 2; stigmas capitate. Fruit of 2 carpels, syncarpous, dehiscing into 2 indehiscent segments (mericarps or cocci), each attached to and often pendulous from a slender biforked axis or elongated thalamus (carpophore) (fig. 194). The pericarp of

each mericarp or half of the fruit is provided with 5 primary and 4 secondary ridges (jugæ), and each of the furrows (vallecule) is traversed by an oil-canal (vitta) (fig. 195). Seeds solitary in each carpel, albuminous.

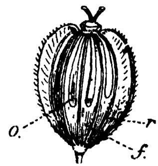


Fig. 195.—Fruit of Coriander or Dhania

r, Ridges. f, Furrows. o, Oil canal.

The Order is mostly confined to the North Temperate Zone. Common plants: **juan** or Ajowan (*Carum copticum*), **mouri** or Fennel or Anise (*Fœniculum vulgare*) (fig. 196), **dhania** (*Coriandrum sativum*), **gajar** or Carrot (*Daucus Carota*), **jeera** (*Cuminum Cyminum*), **sulpa** (*Peucedanum graveolens*), **randhuni** or **channuni** (*Carum Roxburghianum*), all cultivated principally for their fruits which are used as spices. *Carum copticum* is also cultivated for its aromatic oil. Asafœtida or Narthex or **hing** of commerce is probably obtained from *Ferula asafœtida*, Boiss., and imported from Persia, Kashmere, &c. **Thulkurhi** (*Hydrocotyle asiatica*) is a common weed of waste places, with undivided simple reniform crenate leaves (which is rather exceptional in the Order). *Hydrocotyle javanica* is a prostrate herb common in the Khasi Hills. *Bupleurum mucronatum* (see fig. 194) also has simple undivided leaves, yellow flowers, and occurs as weeds in Ranchi, Hazaribagh, and Dera Dun.

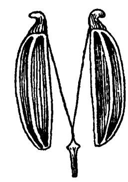


Fig. 196.—Fruit of *Fœniculum*

Small rather inconspicuous flowers of this Order which are either white, greenish, or yellowish, are rendered conspicuous by being aggregated into compound umbels of considerable size. Insects can therefore see them from a distance. Its aromatic odour, often very strong, characteristic of many species,

forms an additional attraction to insects. Nectar is secreted by the epigynous disk, and lies freely exposed in the middle of the flower. As most species are protandrous, cross-pollination by insects is favoured. The aromatic odour of many species serves to protect them from the attack of grazing animals, as is often evidenced in vegetable gardens where clumps of these plants are grown here and there to scare away the cattle. The flowers of the circumference of an umbel sometimes have their outwardly-directed petals enlarged, a contrivance by which the otherwise inconspicuous small umbellate flowers are rendered conspicuous. This enlargement of petals of the circumference-flowers takes place sometimes at the sacrifice of the stamens and carpels.

Fig. 197.—*Panax Pseudo-ginseng*

Nat. Order 17. *Araliaceæ.*—Trees, shrubs, rarely herbs, nearly allied to *Umbelliferæ*, from which they are distinguished in having often more than 2 carpels forming the ovary, and in the fruit not separating into 2 halves, but becoming drupaceous. *Panax fruticosum*, with its decompound or dissected sheathing leaves, is a shrub cultivated in most gardens for its foliage. *Panax Pseudo-ginseng*, Wall. (fig. 197), is a herb met with in the Khasi Hills. *Helwingia*

himalaica is an under-shrub common in Darjiling, with unisexual umbels about the middle of the upper surface of the leaf, and also near about the apex of phyllodes (fig. 198).

Nat. Order 18. *Cornaceæ.* — For the most part shrubs or trees nearly allied to *Umbelliferæ*, from which they are easily distinguished by simple decussate leaves, tetramerous flowers, and fleshy fruits. The inferior ovary made up of 2 carpels does not form a fruit like that of *Umbelliferæ. Cornus capita* is a tree with decussate simple leaves and yellow heads (umbels) of scentless yellow flowers, each head having an involucre of four large white bracts, found in the hills near Dera Dun and Darjiling.

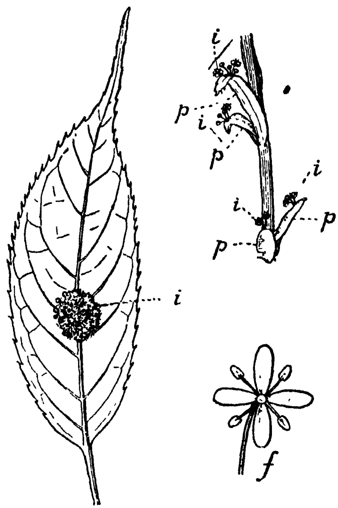


Fig. 198 *Helwingia himalaica*

i, Inflorescence. *f*, Flower. *p*, Phyllodes.

Sub-class 3. COROLLIFLORÆ or GAMOPETALÆ

Nat. Order 1. *Rubiaceæ.*—Trees, shrubs, or herbs, erect or twining, unarmed or armed. Leaves simple, opposite, quite entire, with interpetiolar stipules, sometimes whorled owing to the interpetiolar stipules being rendered foliaceous. Flowers regular, usually tetramerous. Sepals connate into a superior calyx. Petals epigynous, connate, lobes 4, sometimes 5. Stamens epipetalous, equal to the lobes of the corolla.

Carpels connate in an inferior usually 2-celled ovary, sometimes up to 10-celled; ovules 1 or more in each cell. Fruit a 2- to 10-celled berry, drupe, or capsule. Seeds with horny or fleshy albumen.

Common plants of this tropical or subtropical Order: **kaḍamba** (*Anthocephalus Cadamba*), a large tree generally planted for its big globose heads of flowers; **keli-kadamba** (*Adina cordifolia*); **khet-pabrha** (*Oldenlandia corymbosa*), a common weed in rice-fields, used by **kavirajes** (Indian physicians) as a febrifuge; **gandha-raj** (*Gardenia florida* and *G. latifolia*); **rangan** (*Ixora parvifolia* and *I. coccinea*), common ornamental garden shrubs; **moyna** (*Vangueria spinosa*), a highly spinous tree; **gandha-bhadali** or **gandhal** (*Pæderia fœtida*), a fœtid slender twining shrub, the leaves of which when cooked form a good stomachic; **munjishtha** (*Rubia cordifolia*), the roots and branches of which yield a red dye by the name of **munjishtha** (fig. 199). This is a good example of how, by the foliaceous growth of interpetiolar stipules, opposite leaves become whorled; of the four leaves in a whorl, the stipular ones have shorter and smaller blades. *Randia uliginosa* is a small tree with dimorphic flowers; *Chasalia curviflora*, a small shrub of the Khasi Hills, has also dimorphic flowers, one form with stamens exserted and stigmas included, the other with these positions reversed. A species of *Mussænda* grown in our gardens is well known for one of its sepals developing into a large petaloid white leaf. *Adenosacme longifolia* is a shrub of East Bengal and the Khasi Hills, with di- or trimorphic flowers. Among economic plants of great value are

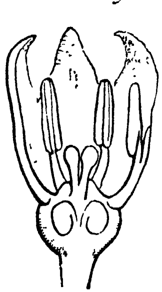


Fig. 199.—Vertical Section of Flower of *Rubia*

the introduced Peruvian Bark or Cinchona tree and the Coffee tree, both now cultivated with profit, the latter principally in southern India and Ceylon, and the former on cool mountain slopes of Darjiling and southern India. From the bark of the Cinchona plant quinine is manufactured. *Cinchona succirubra* is the species mostly grown, though the species *Cinchona calisaya* is not unknown. The cinchona plant was imported from the slopes of the Andes at about 1867, and is now grown in Government plantations in Darjiling and the Ootcamund Hills. The armature of several species of this large family of plants helps them both to climb and to defend themselves from attacks of animals. The Cinchona plants belong to the various species of genus *Cinchona*, and the Coffee plant is *Coffea arabica*. *Myrmecodia armata* has been noticed by Sir J. D. Hooker as an interesting subject of study in respect of its relation to ants, which inhabit its tubers; the tuber, which is depressed at the top, irregularly grooved, and studded with spinules disposed in longitudinal lines, is excavated by ants.

The flowers are often rendered conspicuous by being associated in crowded racemose or corymbose inflorescences. *Ixora* secrete nectar at the bottom of the long corolla-tube, so as to be accessible to long-tongued butterflies only. There are several dimorphic species in this family, some of which have been mentioned above.

Nat. Order 2. *Caprifoliaceæ*.—Mainly inhabitants of the temperate zone, with leaves without stipules, and inferior trilocular ovary, of very little importance in Indian Botany. *Lonicera ligustrina* is a shrub of the Khasi Hills, with flowers in pairs having connate ovaries.

Nat. Order 3. *Valerianaceæ*.—Mostly inhabitants of

the Mediterranean region and of South America. They are herbs or shrubs with decussate leaves, pentamerous spurred corolla, and inferior trilocular ovary, tipped by pappus while in fruit; of no importance in Indian Botany. *Nardostachys Jatamansi* is an Alpine Himalayan herb used in **kaviraji** pharmacopœia.

Nát. Order 4. *Compositæ.* — Herbs or shrubs. Leaves alternate, usually simple. Flowers many, small (florets), aggregated in a head or capitulum, embraced at the bottom by an involucre of bracts; each floret is either embraced by a scaly bracteole called a PALEA or is non-paleated; the florets all tubular, or the inner tubular and the outer ligulate, or all ligulate; all bisexual, or the inner bisexual and the outer female or neuter. Calyx superior, consisting of pappus or scales. Petals epigynous and connate, stamens 4 to 5, epipetalous, syngenesious. Ovary inferior, 1-celled; ovules solitary, basal, erect, anatropous; style usually 2-fid at the top and recurved. Fruit an achene (cypsela) (fig. 200). Seeds single, exalbuminous.

This is the largest family of Dicotyledonous plants, and at the same time one of the best defined and most easily recognized. It is represented in every quarter of the globe. This family possesses only a few plants of economic importance. A few are used in medicine and a considerable number as salad or pot-herbs, amongst which Salad or Lettuce (*Lactuca sativa*) and Artichoke or **hatichoke** (*Helianthus tuberosus*, Linn.) are cultivated in our gardens. Sunflower or **suryamukhi** (*Helianthus annuus*, Linn.), Garden Zinnia (*Zinnia elegans*, Linn. and *Z. pauciflora*, Linn.), **gendha** (*Tagetes patula*, Linn.), and **chandra-mallika** (*Chrysanthemum*) are cultivated as garden flowers all over India. **Sarguja** (*Guizotia abyssinica*) is a stout, erect, annual herb, grown as an oil-seed crop in the

cold season: **kusum-phul** or Safflower (*Carthamus tinctorius*) is a thistle-like herb, cultivated for the orange dye yielded by its flowers, and for oil yielded by its seeds (fruits); the flowers are also used to adulterate Saffron (**jafran**); **aya-pan** (*Eupatorium Ayapana*) is used for its leaves, which are reputed among Indian physicians as a specific for stopping internal

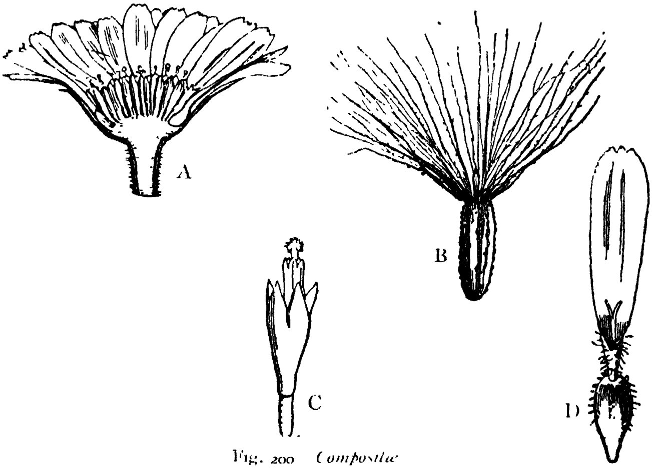


Fig. 200 *Compositæ*

A, Vertical section of capitulum. D, Ligulate, and C, tubular florets of the same. B, Achene with pappus.

hæmorrhage; **kuk-shima** or **kukur-songa** (*Vernonia cinerea*) is a very common annual herb with purplish flowers; *Vernonia anthelmintica* is the **somraj** of Indian **kavirajes**; **barha-** (large) **kuk-shima** (*Blumea lacera*) is also a very common annual weed with yellow flowers; **keshutti** or **keshuria** (*Eclipta alba*) is also a common weed, the juice of the leaves of which is used in tattooing the skin bluish-black; and **hingche** (*Enhydra fluctuans*) is a marsh herb, often collected and eaten as a pot-herb, and reputed to induce sleep.

Adenostemma viscosum is the common **barha-keshutti,** a weed; *Wedelia calendulacea* is the **keshraj** of Indian **kavirajes**; *Elephantopus scaber*, *Grangea maderaspatana*, *Sphæranthus indicus*, *Cæsulia axillaris*, *Centipeda orbicularis*, *Crepis japonica*, *Sonchus oleraceus*, &c., are some of the common weeds. *Siegesbeckia orientalis* (fig. 201) is a shrub with five highly glandular, sticky, spreading, spathulate involucral bracts, common in Chhota Nagpur and Dera Dun.

The small flowers of this family are rendered con-

Fig. 201.—*Siegesbeckia orientalis*
i, Glandular involucre.

spicuous by being aggregated together into heads. The effect is heightened by the ray-florets being often ligulate and differently coloured from the disk-florets. Another effect of crowding is that numerous flowers of the same head are simultaneously pollinated by insects which creep over them in search of nectar or pollen. In the first stage of flowering (anthesis) the anthers, and in the second stage of flowering the stigmatic papillæ, are so far above the general bend of the head that insects must rub against them and cross-pollinate them. But in several cases self-pollination is possible and does take place, for the branches of the style bend back and apply to the stigmatic papillæ the pollen still clinging to the sweeping hairs of the

style. The Linnean class *Syngenesia* corresponds to this Natural Order.

Nat. Order 5. *Campanulaceæ.*—Herbs or under-shrubs with usually hermaphrodite flowers, inferior 2- to 5-celled ovary, 4 to 6 stamens, anthers sometimes syngenesious, corolla regular or irregular. *Lobelia trigona* and *Wahlenbergia gracilis* are common herbs of North Bengal. *Pratia begonifolia* is a herb of Khasi Hills. Of little importance in Bengal.

Nat. Order 6. *Vacciniaceæ.*—Trees or shrubs with hermaphrodite flowers, inferior 5- to 10-celled ovary, 10 stamens, anthers opening by apical pores, corolla tubular or urceolate, sepals usually persistent. **Jalamut** (*Agaptes variegata*) is an epiphytic shrub of Chittagong, and *Vaccinium Griffithianum* (fig. 202) a small tree of the Khasi Hills. Of little importance in Bengal.

Fig. 202.- *Vaccinium Griffithianum* — flowers with urceolate corolla

Nat. Order 7. *Ericaceæ* are trees, shrubs, or herbs with hermaphrodite flowers, ovary superior, usually 5-celled, stamens usually 10, anthers opening by apical pores, often produced upwards into tubes, sometimes spurred, corolla campanulate or urceolate. *Gaultheria fragrantissima*, a shrub, and *Pieris ovalifolia*, a tree, are common in the Khasi Hills. *Rhododendron Hookeri* is the shrub of Darjiling and the Sikim Himalayas well known for its red blazing clusters of flowers, as also is *Azalea* with clusters of large white or yellowish-white flowers.

Nat. Order 8. *Sapotaceæ.*—Trees or shrubs bearing

latex, young parts often rusty tomentose. Leaves alternate, petioled, entire, coriaceous. Stipules, when present, very caducous. Flowers regular. Sepals connate in a calyx with 4 to 8 imbricated lobes, sometimes in 2 series, the inner series imbricate and the outer valvate, persistent. Petals connate in a tube shorter than the calyx, the lobes as many as, or two to four times as many as the calyx-lobes. Stamens epipetalous, either in 1 series and as many as and opposite the corolla-lobes, or in 2 to 3 series and twice or thrice as many as the corolla-lobes. Carpels connate in a superior 2- to 8-celled ovary. Fruit 1- to 8-seeded berry. Seeds exalbuminous with usually crustaceous testa. The Order is wholly tropical. Common plants: **sapota** (*Achras Sapota*), a native of America, cultivated in our gardens for its edible fruit: **mahua** (*Bassia latifolia*), the dried sweet waxy flowers of which are used as food by the poor people of Chhota Nagpur and Behar and also for distilling a kind of country liquor, while the seeds yield a kind of oil known as "Vegetable butter", largely used to adulterate **ghee**; **bakul** (*Mimusops Elengi*) (fig. 203), a tree often cultivated for its handsome coriaceous leaves and fragrant flowers in axillary fascicles; the sepals in 2 whorls; petals in 3 whorls of 8 each, the inner whorl forming a cone over the stamens, the other two outer whorls being really scales at the back of the petals of the inner whorl; stamens 8, interspersed with a whorl of hairy staminodia.

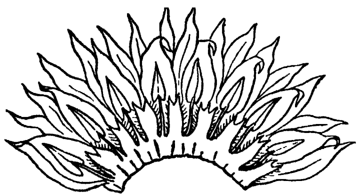


Fig. 203.—Bakul (*Mimusops Elengi*) corolla spread out showing stamens and staminodia

The glabrous elliptic leaves of **bakul**, with their apices pointing downwards, form an unbroken sloping canopy which, like a gabled roof, shoots off the rain water and makes it fall on a circular zone of earth at a distance from the main trunk. The underground root-system is developed in accordance with the aerial branch-system, so that the sucking tips of the laterally-spread roots are all disposed in the rain-soaked circular zone of earth mentioned above. The same phenomena may be studied with advantage in the branch-system of the root and of the stem of **aswathwa** or Peepul tree.

Further, the inconspicuous dull-white flowers of **bakul** are rendered highly attractive by their strong aromatic odour, and the bees visit them in swarms, getting as their reward a good feed of honey secreted within the flowers.

Nat. Order 9. *Ebenaceæ*.—Trees or shrubs, without latex, wood usually hard and heavy. Leaves alternate, entire, usually coriaceous. Flowers usually diœcious or polygamous. Sepals connate in an inferior calyx, lobes 3 to 7, often accrescent. Petals connate in a tube, lobes 3 to 7. Stamens in 1 series and as many as the corolla-lobes; or in 2 to several series and 2 to several times as many as the corolla-lobes. Carpels connate in a superior ovary, with 2 to 8 styles, and the cells as many or twice as many as the styles. Fruit drupaceous or berry, several- or few-seeded. Seeds with copious albumen.

The Order is chiefly tropical. The genus *Diospyros* contains several species which yield a hard intensely black wood, to all of which the general name of **abloosh** or Ebony is given. Among the ebony-yielding species the following may be specially mentioned, —*Diospyros tomentosa*, *D. Ebenum*, and *D. melan-*

oxylon, which grows in the hills of Bengal, Orissa, Bhutan, and Nepal. *Diospyros Kaki* is a Japanese tree very commonly grown about Calcutta as a fruit tree. *Diospyros Embryopteris* is known in Bengal as **gaub** tree; the astringent viscid mucus of its fruit is used all over Bengal for paying or smearing the bottoms of boats and for steeping fish-nets in order to make them water-tight. *Diospyros cordifolia* is **ban-gaub.** *Maba buxifolia* (fig. 204) is a common tree in Orissa.

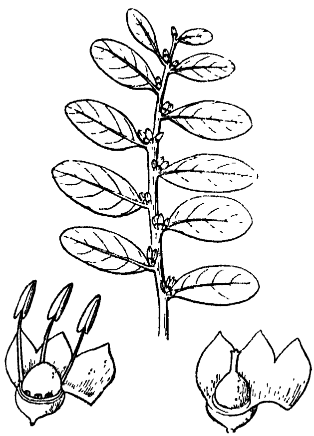


Fig. 204.—*Maba buxifolia*

Nat. Order 10. *Styraceæ.*—Distinguished from *Ebenaceæ* in having hermaphrodite white flowers, numerous stamens, single style, and the ovary inferior. It is represented in Bengal by **lodh** (*Symplocos racemosa*), a tree the bark of which is used in dyeing and is sometimes powdered for **abir**; and by **booree** of Sylhet (*Symplocos spicata*), a tree, the hard seeds of which are strung together as beads and put round the necks of children.

Nat. Order 11. *Myrsinaceæ.*—Trees with alternate simple gland-dotted leaves with small regular flowers. Stamens 4 to 5, opposite the corolla-lobes, ovary superior, 1-celled with free-central placentation, fruits succulent. *Ægiceras majus* (**hulsi**) is a small tree in the delta of the Ganges characterized by breathing-roots standing upright out of the soil all round the tree. The stamens are monadelphous. *Ardisia humilis* (**ban-jam**) is a small tree. The Order is closely

allied to *Primulaceæ*, which are, however, herbs with dry fruits and never trees with succulent fruits.

Nat. Order 12. *Plumbaginaceæ.*—Herbs with regular 5-merous flowers, stamens superposed to the corolla-lobes, ovary 1-celled, superior, with 5 free styles. The plants of this order mostly grow in salt marshes. **Chita** (*Plumbago zeylanica*) and *Plumbago rosea* (**lal-chita**), shrubs well known for their poisonous roots.

Nat. Order 13. *Oleaceæ.*—Trees or shrubs, erect or climbing. Leaves usually opposite, simple or pinnate. Flowers regular, sometimes polygamous or diœcious, usually in di- or trichotomous cymes. Sepals inferior, connate, usually truncate or 4-lobed. Petals usually 4 to 6 in a gamopetalous corolla. Stamens usually 2, epipetalous. Carpels connate in a superior 2-celled ovary. Fruit a loculicidal capsule or a berry or a drupe. Seeds usually albuminous.

The order is distributed in temperate and tropical regions. Common plants: **bela** or **bael-phul** or **mallika** (*Jasminum Sambac*), **juin** (*Jasminum auriculatum*), **kund** (*Jasminum pubescens*), **sheuli** or **shephalika** (*Nyctanthes Arbor-tristis*), are all commonly-cultivated garden plants. They all bear characteristic moth-flowers, that is, flowers possessing white colour, and strong aromatic odour specially noticeable towards evening and wholly or partially wanting during the day, and opening after dark. In fact, the whole family is characterized by moth-flowers. *Ligustrum robustum* is a tree of East Bengal and Assam with conspicuous lenticels in the branches.

Nat. Order 14. *Apocynaceæ.*—Herbs or shrubs, twining or erect, often with milky juice. Leaves opposite or whorled, entire. Flowers regular, hermaphrodite. Sepals usually 5, connate in an inferior calyx, lobes imbricate. Petals usually 5, rotate or

hypocrateriform, lobes spreading, and twisted in bud. Stamens usually 5, epipetalous. Carpels usually 2, superior, free in the region of the ovary but united in the region of the style and stigma; stigma often thickened and dumb-bell-shaped. Fruit a pair of follicles or a pair of drupes or berries, sometimes single by abortion. Seeds often winged or tipped by a crown of long silky hair (coma), usually albuminous.

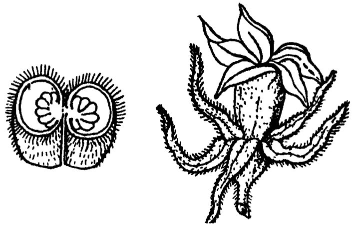


Fig. 205.—Malati (*Aganosma caryophyllata*)

The Order is chiefly tropical. Common plants: (1) **karabi** (*Nerium odorum*), a garden shrub; (2) **tagar** (*Tabernæmontana coronaria*), a cultivated garden shrub; (3) **kálika-phul** or **háldi-kárábi** (*Thivetia nerifolia*), common in gardens and also as garden-escapes; (4) **malati** (*Aganosma caryophyllata*) (fig. 205), a large climber often planted in gardens for its handsome fragrant flowers; (5) **karancha** (*Carissa Carandas*), a spinous shrub cultivated for its acid berries; (6) **kat-champa** (*Plumeria acutifolia*), a small-sized tree of our gardens; (7) **nayan-tara** (*Vinca*

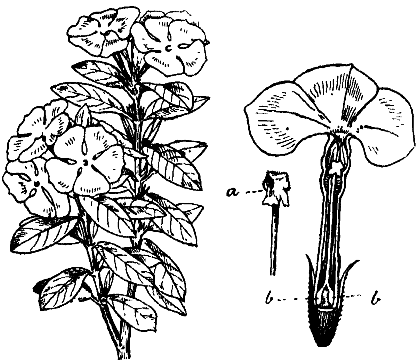


Fig. 206.—Nayan-tara (*Vinca rosea*)
a, Stigma. *b*, Free ovaries.

rosea) (fig. 206), planted in gardens for its handsome white or pink flowers; (8) **chhatim** (*Alstonia scholaris*), a tall tree with whorled leaves; (9) **kurhchi** (*Holarrhena anti-dysenterica*) (fig. 207), a wild tree, the bark of which yields a decoction which is a specific for dysentery; (10) **dudhi-lata** or **shamalata** (*Ichnocarpus frutescens*), a climbing shrub. *Willughbeia edulis*

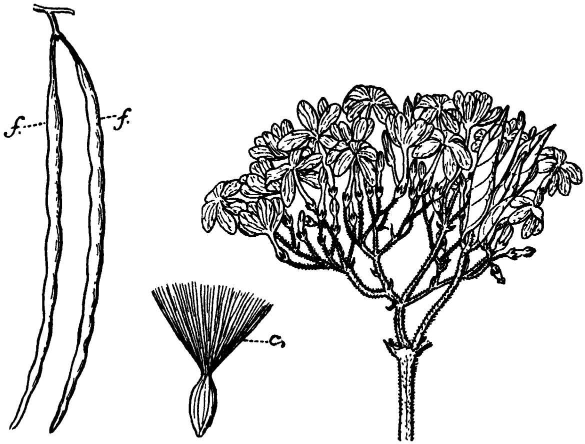


Fig. 207.—Kurhchi (*Holarrhena anti-dysenterica*)

f f, Pair of follicles. *c*, Coma on the crown of a seed.

(lata-am) is a climbing shrub with peduncles converted into tendrils.

The homogamous large fragrant flowers of **karabi** are typical butterfly-flowers. The large funnel-shaped corolla with spreading limbs, incised corona, and nectar-guides is provided with nectar concealed at its bottom. The entrance to the flower is blocked by the corona, and a woolly ball formed of the twisted filiform appendages of the stamens is placed in such a way that only long-tongued strong butterflies are

able to penetrate to the nectar. The mechanism of the flowers of *Vinca rosea*, **tagar** and **malati**, excludes autogamy and induces allogamy.

Nat. Order 15. *Asclepiadaceæ*.—Herbs or shrubs, usually twining, with milky juice. Leaves usually opposite, entire. Sepals 5, connate in an inferior calyx. Petals 5, connate, lobes valvate, throat of the corolla with a corona of hairs, scales, or processes. Stamens 5, the filaments united in a hollow column

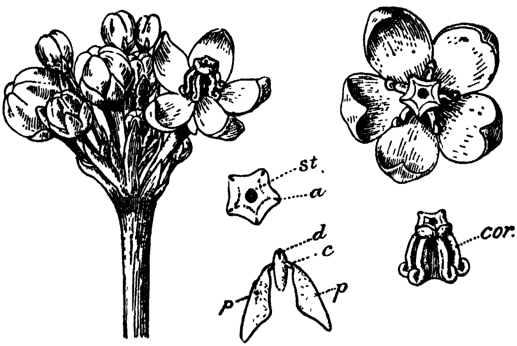


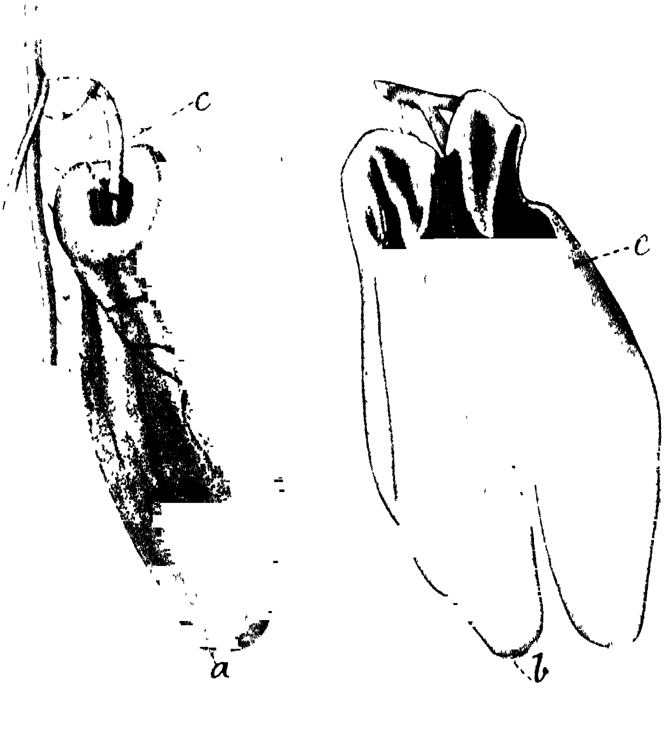
Fig. 208.—Akanda (*Calotropis gigantea*)

st, Stigma. *a*, Anther. *d*, Disk. *c*, Caudicle. *p*, Pollinia. *cor*, Corona.

enclosing the style; anthers adnate to the stigma (gynandrous), pollen-grains aggregated into 1 or 2 pollinia in each anther-lobe, the pollinia being united in pairs or fours to a gland (retinaculum) on the stigma. Carpels, fruits, and seeds as in *Apocynaceæ*.

The Order is chiefly tropical. Common plants: **akanda or madar** (*Calotropis gigantea*) (fig. 208); *C. procera* or **safed akanda**; **ananta-mul** or Indian Sarsaparilla (*Hemidesmus indicus*), a thin twining shrub; *Stephanotis floribunda*, a large garden climber with handsome white fragrant flowers; different species of *Hoya*, which are twining epiphytes with thick coria-

PLATE VI



Dischidia Rafflesiana

a, whole pitcher; *b*, same, cut open; *c*, rootlets

ceous leaves and clusters of white or cream-yellow flowers. *Dischidia Rafflesiana* (Plate VI) of Sylhet and Cachar is a stout twiner with pitchers 2 to 5 inches long, the cavity of which is filled with water and rootlets from the adjoining node.

The Order is closely allied to *Apocynaceæ* in habit and structure of the pistil, fruit, and seeds, but differs from it in valvate (not twisted) corolla, pollen-grains in masses, and anthers adnate to the stigma.

Nat. Order 16. *Loganiaceæ.*—Many genera of this family may be regarded as *Rubiaceæ* with a superior ovary. Like *Rubiaceæ*, *Loganiaceæ* are usually provided with interpetiolar stipules. Two well-known plants of this order are (1) **kuchila** (*Strychnos Nux-vomica*), a tall tree from the seeds of which the alkaloid strychnia is extracted, and (2) **nirmalli** or Clearing nut (*Strychnos potatorum*), a tree the seeds of which are rubbed into a paste, and the paste added to dirty water causes the impurities to settle to the bottom. *Mitrasacme alsinoides* (fig. 209) is a small herb common in waste places.

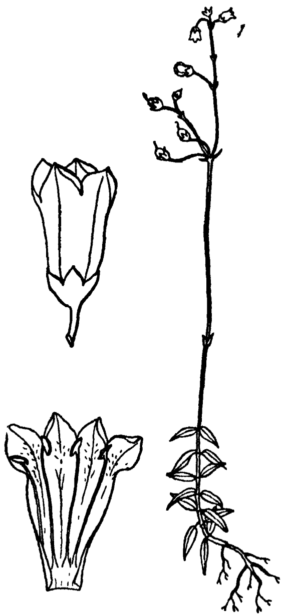


Fig. 209.—*Mitrasacme*

Nat. Order 17. *Gentianaceæ.*—A cool-climate family abundant in mountainous regions, represented by three or four species of aquatic plants of the plains of Bengal belonging to the genus *Limnanthemum*

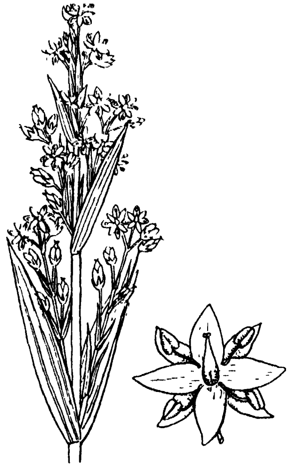


Fig. 210.—Chireta (*Swertia Chirata*)

(**patari** or **pan-sheuli**), very common in our tanks, having white or whitish-yellow flowers with fringed corolla; and **chireta** (*Swertia Chirata*) (fig. 210), a shrub that grows in the Himalayas and affords the well-known medicinal leaves known as **chireta,** which, when steeped in water, yield a bitter stomachic infusion. There are a few dimorphic species in this order. *Canscora diffusa* is a common dichotomously-branched herb with the upper leaves (fig. 211) connate.

Nat. Order 18. *Boraginaceæ.*—Herbs, shrubs, or trees, often hispid (rough). Leaves usually alternate, entire. Flowers regular, usually in scorpioid cymes. Sepals connate in an inferior calyx, lobes 5, usually imbricate. Petals 5, lobes 5, imbricate. Stamens 4 to 6, epipetalous. Carpels connate in a superior 4-lobed (fig. 212), 2- to 4-celled ovary, each cell 1- to 2-ovuled. Style

Fig. 211.—*Canscora diffusa*

c. Connate leaf.

usually gynobasic (rising from between the lobes of the ovary as if from its bottom). Fruit dividing into 2 to 4 nutlets or drupe-like segments. Seeds with fleshy albumen.

Its distribution is general. The only commonly occurring and well-known plant is **hati-soonrh** (*Heliotropium indicum*) (see fig. 73), a common roadside weed with small pale-blue flowers arranged in a spike-like cyme. *Cordia Sebestena*, Linn. is a small tree often planted in gardens for its handsome big orange-red flowers.

The Order is closely allied to *Labiatæ* in the structure of the ovary, but differs from it in having regular flowers, and stamens not didynamous.

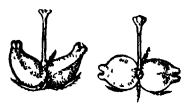


Fig. 212.—Four-lobed Ovary of Hati-soonrh (*Heliotropium indicum*) with Gynobasic Style

Nat. Order 19. *Convolvulaceæ*.—Usually twining herbs or shrubs, sometimes parasites. Leaves alternate. Flowers regular. Sepals inferior, 5, imbricate, often persistent, sometimes accrescent. Petals 5, connate in a campanulate or infundibuliform corolla, lobes of the limb usually plicate and twisted. Stamens 5, epipetalous. Carpels 2, connate in a superior ovary; cells as many as, or, by false dissepiment, twice as many as the carpels; ovules 2 in each cell when the ovary is 2-celled, 1 in each cell when the ovary is 4-celled; stigma 2-fid or 2-lobed. Fruit a berry or a capsule. Seeds usually exalbuminous, with plaited or crumpled foliaceous green cotyledons.

The Order is chiefly tropical. Common plants: **lal-aloo** or **ranga-aloo** or Sweet Potato (*Ipomœa Batatas*), of two varieties, one yielding red and the other white tuberous roots, the white variety being known as **chiner-aloo**; **kálmi-shag** (*Ipomœa reptans*),

a common aquatic herb with sagittate leaves often used as a vegetable; **bhuin-kumrha** (*Ipomœa paniculata*); *I. pes-tigridis*, a hirsute twining plant with 3- to 9-lobed leaves (fig. 213), and several other species of *Ipomœa*; **táru-láta** (*Quamoclit pinnata*), cultivated as a garden climber, with its pinnately-dissected leaves and deep-red tubular flowers; **sámudra-shok** (*Argyreia speciosa*), an extensive garden climber with cordate leaves, which are silvery on the under surface,

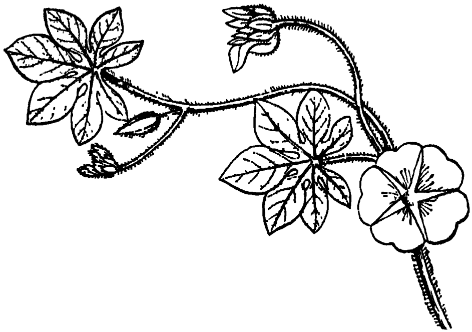


Fig. 213.—Langii-lata (*Ipomœa pes-tigridis*)

with silky hairs and large rose-coloured flowers; **alak-láta** or Dodder (*Cuscuta reflexa*) (see fig. 4), a common leafless twining whitish-yellow thread-like parasitic herb. The seeds of *Cuscuta* germinate in the soil, and the seedling lays hold of some neighbouring plant to which it attaches itself early in life by suckers. When thus well established on its host, its connection with the ground is cut off and the plant becomes wholly parasitic. Compare *Cuscuta* with *Cassytha* (*Lauraceæ*), which is a parasite similar in appearance to *Cuscuta*, but pale-green instead of pale-yellow.

The flowers are usually brightly coloured and

adapted to insect-visits. In many cases they remain open only for a day or even a few hours, and then close permanently (pseudo-cleistogamous).

Nat. Order 20. *Solanaceæ.* — Herbs or shrubs. Leaves alternate. Flowers regular, often in cymes. Sepals and petals as in *Convolvulaceæ*. Stamens 5, epipetalous, with anthers often apparently connate, with porous dehiscence. Carpels as in *Convolvulaceæ*; ovules many in each cell. Fruit as in *Convolvulaceæ*, only many-seeded and not four-seeded as in the latter.

Fig. 214.—Ram-begoon (*Solanum ferox*)

The Order is chiefly tropical. Common plants: **belati-aloo, aloo,** or **gol-** (round) **aloo** or Potato (*Solanum tuberosum*), the tuberously-grown underground branches of which form the Potato; **begoon** or Brinjal or Egg-plant (*Solanum Melongena*), the fruits of which are used as a common vegetable; **kuli-begoon** or **puli-begoon** or Long-Brinjal (*Solanum Melongena* var. *esculenta*), also used as a vegetable; **belati-begoon** or Tomato (*Lycopersicum esculentum*), the red globose pulpy fruits of which are much esteemed for making sauce; **kánti-kari** (*Solanum xanthocarpum*), a prickly herb of waste places, used as a medicinal plant by the Indian physicians; *S. ferox* or **ram-begoon** (fig. 214) is a stout prickly herb; **lánka** or **lánka-márich** or **jhal** or Chillie or Cayenne pepper is a scarlet or orange-yellow fruit produced by several cultivated species and varieties of *Capsicum*, and used as a common condiment; **tepari** or Cape Gooseberry (*Physalis peruvi-*

ana), the pulpy edible berries of which lie concealed within a yellow accrescent calyx; **dhutura** or Thorn Apple (*Datura Stramonium*), the seeds of which are highly poisonous. Notice that in cross-sections of the young fruit it is 2-celled at the top and 4-celled at the bottom; **tamak** or Tobacco (*Nicotiana Tabacum*); **áswágándha** (*Withania somnifera*), cultivated for its reputed alexi-pharmic properties. Besides Tobacco and *Datura*, there are several other narcotic and poisonous plants, such as *Atropa Belladonna*, *Hyoscyamus*, &c.

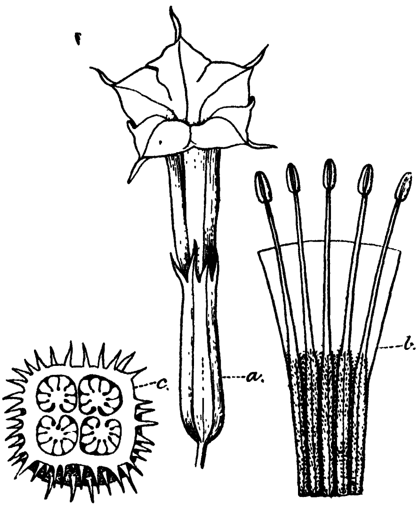


Fig. 215.—Dhutura (*Datura Stramonium*)
a, Whole flower with tubular calyx. *b*, Infundibuliform corolla cut open. *c*, Four-celled ovary.

The Order is allied to *Convolvulaceæ*, but differs in habit, and in having many-seeded fruits.

Datura Stramonium (fig. 215) bears homogamous moth-flowers which secrete honey at the base of the ovary, and possess a well-marked disagreeable musky odour, and when freshly opened the odour is stronger in the evening than during the day. As night-flowers they have no nectar-guides and are white in colour, sometimes with a pink or bluish tinge. The big funnel-shaped corolla closes periodically, and always in dull weather. A variety with drooping flowers is found in gardens. *Nicotiana Tabacum* with nectar-

flowers, and *Solanum tuberosum* with pollen-flowers, are both autogamous as well as allogamous.

Nat. Order 21. *Acanthaceæ.*—Herbs or shrubs. Leaves opposite, almost always entire. Flowers irregular, usually in cymes, racemes, or spikes which are largely bracteated. Sepals 4 or 5, inferior, sometimes slightly connate. Petals 5, connate in a 2-lipped (bilabiate) or irregular corolla; lobes imbricate or twisted in bud. Stamens 4, didynamous, or by abortion 2 (as in *Justicia*), epipetalous. Carpels 2, connate in a superior 2-celled ovary; ovules usually many in each cell; style terminal, stigma usually 2-lobed. Fruit a loculicidal capsule; the valves often separate elastically during dehiscence. Seeds attached to hard hooked supports (retinacula), usually exalbuminous.

This is a large tropical family which includes many insignificant weeds and many species with handsome flowers. Common plants: **bakás** (*Adhatoda Vasica*) (see fig. 112), a dense shrub, with bracteated spikes and diandrous flowers; **jhanti** is the common name given to the different species of *Barleria* with didynamous stamens, two of which are present in an abortive state; **kule-kharha** (*Hygrophila spinosa*), an erect highly-spinous marshy herb much used by Indian physicians as a remedy for diarrhœa; **kal-megh** (*Andrographis paniculata*), an Indian specific for fever; several species belonging to the diandrous genus of *Justicia*; several species of *Ruellia*; **nil-láta** (*Thunbergia grandiflora*), a big climbing woody perennial of our gardens with large blue *Convolvulus*-like flowers, which, as well as the twining habit, may make one mistake the plant as belonging to *Convolvulaceæ*.

Flowers are mostly dichogamous, nectar-yielding, brightly-coloured, and aggregated into conspicuous inflorescences, and thus adapted to cross-pollination.

The Order is closely allied to *Labiatæ* in the structure of the corolla and stamens, but differs from the latter by 2-celled unlobed or undivided ovary, terminal style, capsular many-seeded fruit, and bracteated inflorescence.

Nat. Order 22. *Labiatæ.*—Herbs, often aromatic. Stems usually square. Leaves opposite or whorled. Flowers irregular, often bilabiate, solitary, or in fascicled axillary cymes. Sepals, petals, and stamens as in *Acanthaceæ.* Carpels 2, superior, connate in a 4-celled 4-lobed ovary; style simple, gynobasic; ovules 1 in each cell. Fruit concealed at the bottom of the cup-shaped persistent calyx, and splitting into FOUR 1-SEEDED NUTS or PYRENES. Seeds erect, exalbuminous.

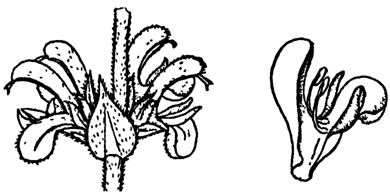


Fig. 216.—Bhuin-tulsi (*Salvia plebeja*)

Chiefly belonging to the north temperate regions. Common plants: **tulsi** of various kinds belonging to the genus *Ocimum*; **ghál-ghάse** (*Leucas aspera* and *L. linifolia*), common weeds of rice-fields during winter, with white flowers; **bhuin-tulsi** (*Salvia plebeja*) (fig. 216), an annual weed; genus *Salvia* has two stamens with short filaments attached to a transversely elongated connective, the long upper curved arm of which bears one fertile anther-lobe and the short lower arm bears a barren anther-lobe (DISTRACTILE), specially adapted for pollination by bees: the elongated connective is rocking, and, on being moved by the alighting of a bee, brings the anthers in contact with the back of the bee; **guma** (*Leonurus sibiricus*), a tall annual weed with opposite axillary cymose clusters of purple flowers and pinnately-incised leaves,

common on roadsides. Several are used as pot-herbs, such as **poodina** or Mint (*Mentha arvensis*), *M. viridis* L., *M. piperita* L., *M. aquatica* L., Sage (*Salvia*), &c. The fragrant oils of some species, as *Lavandula* (Lavender) (fig. 217), *Pogostemon* (patchouli) are in great request as perfumes.

The small flowers are rendered conspicuous from

Fig. 217.—*Lavandula*

s, Gynobasic style. *c*, Persistent calyx. *o*, Enclosed four-lobed ovary.

being aggregated together in crowded inflorescences. In *Ocimum*, in the first stage of flowering, the stamens curve upwards and the styles curve downwards; in the second stage their positions are reversed, so that the insect-visitors touch either the stamens or the style only, and thus effect cross-pollination. The flowers of *Salvia* show a wonderful contrivance for securing cross-pollination by bees as described above. Closely allied to *Acanthaceæ*, but differs from the latter in the points referred to already under *Labiatæ*.

Nat. Order 23. *Verbenaceæ.*—Herbs, shrubs, or trees. Leaves opposite or whorled, simple or digitate, rarely pinnate. Flowers irregular. Sepals, petals, and stamens as in *Acanthaceæ* and *Labiatæ*. Carpels 2, connate in a superior 2- to 4-celled, 4-lobed, or entire ovary; style as in *Acanthaceæ*; ovules solitary or 2 in each cell. Fruit a drupe or berry, rarely capsular, 4-, 2-, or 1-celled, cells 1-seeded. Seeds erect, exalbuminous.

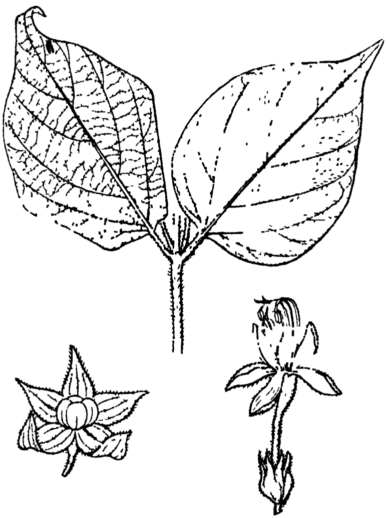


Fig. 218.—Ghentu or bhant (*Clerodendron infortunatum*)

Chiefly tropical. Common plants: **sagoon** or Teak (*Tectona grandis*), a tree 80 to 120 feet high, of first importance in India as affording one of the best and most durable timbers known, having flowers in dichotomous panicled cymes with 5 to 6 stamens, and fruit a drupe enclosed within a persistent calyx; **ghentu** or **bhant** (*Clerodendron infortunatum*) (fig. 218), an erect shrub supposed to have the power of exorcising the evil spirit which presides over the disease known as itch (**khosh**); **nishinde** (*Vitex Negundo*), a common shrub or tree with trifoliate or quinate leaves; **gambhari** (*Gmelina arborea*) (fig. 219), a timber tree of Orissa jungles 40 to 60 feet high; *Lantana indica*, a waste-land shrub having the evil repute of generating malarious fever; *Verbena officinalis*, also a small

weed of waste places; *Holmskioldia sanguinea*, a tree common in gardens in Calcutta, with beautiful scarlet flowers, conspicuous for their scarlet-coloured persistent gamosepalous ample bell-shaped truncate persistent calyx; **belati-mehdi** (*Duranta Plumieri*), an erect shrub, largely used as a hedge plant in gardens;

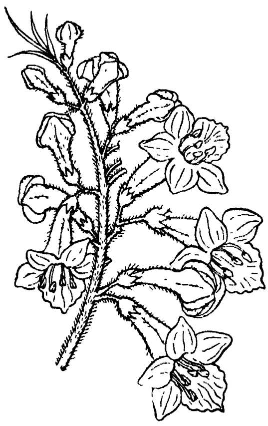


Fig. 219.—Gambhari (*Gmelina arborea*)

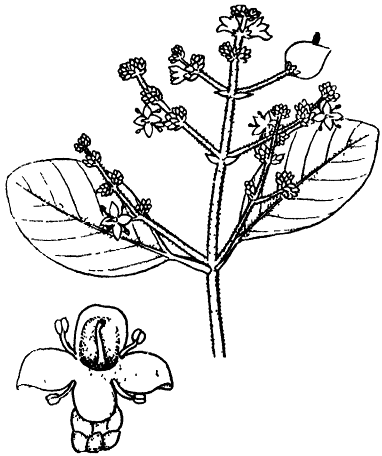


Fig 220.—Bina (*Avicennia officinalis*)

Avicennia officinalis (**bina**) (fig. 220), a common tree in the Sunderban. The Order is closely allied to both *Acanthaceæ* and *Labiatæ*. From the former it differs in having 4-celled ovary with 1 seed in each cell, or 2-celled ovary with 2 seeds in each cell; from the latter in terminal style and drupaceous or berry-like fruit.

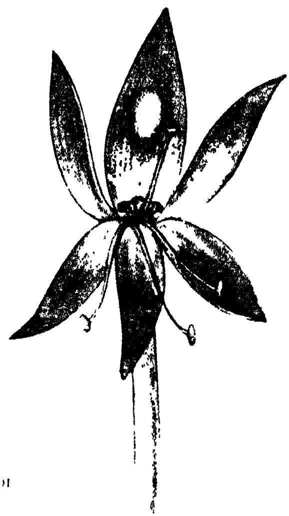
Nat. Order 24. *Scrophulariaceæ*.—Herbs or shrubs, rarely parasitic. Leaves opposite or alternate or both. Calyx, corolla, and stamens as in *Acanthaceæ* and *Labiatæ*, only corolla is sometimes personate, often spurred. Ovary superior, 2-celled, with many seeds

in each cell; the placenta central, or the septum itself is placentiferous throughout. Fruit capsular. This is a large family of almost universal distribution, including many Indian species, most of which are insignificant weeds and a few are garden plants. Common plants: Snapdragon (*Antirrhinum majus*), a common "season" flower of our gardens, with deep-red or yellow conspicuous flowers, personate corolla saccate at the base, and 2-celled capsule opening by 2 pores; *Lindenbergia urticifolia*, a diffuse annual weed found in the rains, growing on old brick walls and window-sills, with small axillary solitary yellow flowers and personate corolla, having its mouth closed by 2 gibbous projections or palate of the lower lip; *Linaria ramosissima* (Plate VII, fig. A), a prostrate herb with sagittate leaves and yellow flowers, with a spurred and personate corolla; *Scoparia dulcis*, a rigid perennial herb common in waste places, with white tetramerous flowers, equal (not didynamous) stamens, and the corolla throat densely bearded; *Herpestis chamædroides* Linn., a small weed of garden paths and moist waste places, with square stems and white or whitish-yellow small flowers seen at the close of the rains, and globose fruits dehiscing into 2 valves, leaving the placentiferous septa free in the middle. *Centranthera hispida*, an erect weed with purple flowers; *Sopubia trifida*, with trifid filiform leaves and yellow flowers.

The Order is characterized by flowers rendered conspicuous by brightly-coloured corolla. Yellow and red predominate. In many instances the flowers are dichogamous. Those with a long corolla-tube open or closed at the mouth by a palate are pollinated by the stronger bees; those with short, campanulate, widely-open corolla are chiefly visited by wasps. In

PLATE VII

A. *Linaria ramosissima*



B. Flower of *Eichhornia crassipes*, Water Hyacinth (bilati pana or kachuri)

several species autogamy is impossible, while in others autogamy takes place when allogamy fails. The Snapdragon mentioned above bears homogamous bee-flowers with a valvular mechanism closing the throat of the corolla-tube. The anthers are included and set close against the upper lip, so that their pollen-grains adhere to the back of the bee, which effects its entrance into the flower by forcing down the closing palate. The Order is closely allied to *Acanthaceæ*, from which it is distinguished mainly by the nature of the placentation, and often by the absence of bracteated inflorescence.

Nat. Order 25. *Orobanchaceæ*.—Leafless root-parasites. Stem a flowering scape. Flowers like those of *Scrophulariaceæ*. Ovary 1-celled, with numerous ovules on parietal placentas, which sometimes meet in the centre of the ovary.

The distribution is temperate and tropical. Common plants: **bania-bau** (*Orobanche indica* and *O. cernua*) (Plate VIII, fig. B), which are leafless erect parasites on the roots of Tobacco, Poppy, Mustard, Brinjal, and other winter field-crops, on which they cause havoc if well established; *Æginetia pedunculata* (Plate VIII, fig. A) is a parasite on **khus-khus** (*Andropogon squarrosus*) and other grasses. The first two species have homogamous bee-flowers.

Nat. Order 26. *Utriculariaceæ*.—Herbs growing in water or damp places. Leaves when submerged are divided into capillary segments bearing small bladders or utricles. Flowers bilabiate; stamens 2; carpels 2, connate in a 1-celled superior ovary, with free-central placentation.

Distribution both tropical and temperate. Common plants: different species of *Utricularia* (see fig. 66), common in ponds and ditches and marshy places,

called in Bengali by the name of **chhota-** (small) **jhangi**: the utricles or bladders in these plants have an opening shut by a valve which opens inwards and is beset with long erect hairs. The inner wall of the utricles is studded with 3-forked glands (see fig. 67). Water fills the utricles. Little snails and water-insects, chased by bigger insects, easily enter the bladders for shelter by pushing down the valve, but cannot get out, as the valves do not open outwards. Thus imprisoned, the little animals soon die, and are digested by the juice secreted by the glands. Hard and indigestible remains of the animals captured are often met with within the bladders. The hairs at the mouth of the bladder probaby prevent the pursuit of bigger chasing insects.

The flowers of *Utricularia* are yellow and homogamous. The entrance to the flower is closed by the close application of the upper and lower lips, and the lower lip serves as an alighting-platform for insects, which by their weight depress it. The stigma is sensitive, and bends upwards and backwards at the touch of an intruding insect. Most plants of this Order capture and digest insects.

Nat. Order 27. *Gesneraceæ.*—Herbs closely allied to *Acanthaceæ* and *Scrophulariaceæ*, but readily distinguished by didynamous or diandrous stamens, with their anthers apparently connate, in pairs. Mostly subtropical and temperate. A few plants of this order, belonging to the genera of *Didymocarpus*, *Chirita*, &c., are found in the hilly tracts of Chittagong and Chhota Nagpur. The leaf, when solitary on the plant, is sometimes a highly-developed cotyledon, as in the Nepal herb *Platystemma violoides* (fig. 221). Some few are epiphytes, as *Æschynanthus bracteata*, found at a height of 7000 feet in Darjiling.

A. *Aeginetia pedunculata*

B. *Orobanche cernua*: parasite on the root of brinjal (*a*)

Nat. Order 28. *Bignoniaceæ.*—Trees or shrubs, sometimes climbing. Leaves opposite, pinnate. Flowers and ovary as in *Acanthaceæ.* Fruits usually elongated like a pod. Seeds usually prominently winged.

Fig. 221. *Platystemma violoides*
o, Persistent cotyledon (only leaf).

Chiefly tropical. Common plants: Indian Cork-tree (*Millingtonia hortensis*), a tall tree (80 feet), generally planted on road-sides; **parul** (*Stereospermum suaveolens* (fig. 222), a tree 30 to 60 feet high; **atkapali** (*Stereospermum chelonoides*), also a tree 30 to 60 feet high; *Oroxylum indicum*, a tall tree common throughout India, with ternately bipinnate big leaves, and sword-shaped fruits 2 to 3 feet long, 2 to 4 inches broad, and $\frac{1}{3}$ inch thick; *Tecoma stans* Linn. is a scandent garden shrub.

Nat. Order 29. *Pedaliaceæ.* — Herbs or under-shrubs. Flowers like those of *Acanthaceæ.* Seeds wingless.

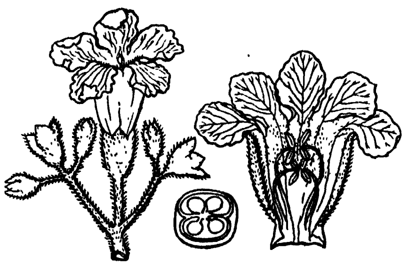


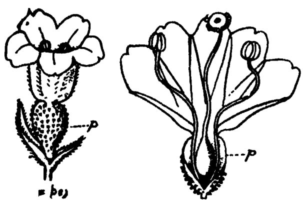
Fig. 222.—Parul (*Stereospermum suaveolens*)

A small family distributed in the warmer parts of the globe. Common plants: **til** or Sesame or Gingelly (*Sesamum indicum*), cultivated largely as an oil-seed crop; **bag-nakha** (*Martynia diandra*), an American weed called Tiger-

claw, now common in the Gangetic plains and elsewhere in India. It has capsules with 2 incurved beaks like the claws of a tiger (see fig. 128). By means of these beaks the capsules become attached to the hair or wool of wild animals and are thus dispersed.

Sub-class 4. INCOMPLETÆ

Nat. Order 1. *Nyctaginaceæ.*—Herbs, shrubs, or trees. Leaves usually opposite, entire. Flowers hermaphrodite, regular, often involucrate. Perianth usually petaloid, connate, inflated at the base, enclosing the ovary. Stamens 8 to 30, hypogynous. Carpels form a 1-celled superior ovary, with 1 erect ovule, enclosed within the inflated base of the perianth. Fruit membranous, indehiscent, enclosed within the coriaceous, persistent perianth base. Seeds erect, albuminous. The Order is found chiefly in tropical America. Common plants: **krishná-káli** or Marvel of Peru (*Mirabilis Jalapa*), a native of America, largely cultivated in our gardens; various species of *Boerhaavia*, known by the Bengali name of **punar-naba,** and much used as a medicinal herb by our **kavirajes,** e.g. *B. repens* (fig. 223); **bagan-bilas** (*Bougainvillea glabra* and *B. spectabilis*), common climbers of our gardens, also American, cultivated for their showy purple bracts. They climb by means of axillary recurved spines, and bear inconspicuous flowers arising from the mid-rib of each of the three large leafy purple bracts which form a sort of invo-



Section

Fig. 223.—Punar-naba (red) (*Boerhaavia repens*)

p, Perianth enclosing ovary.

lucre; **bagh-anchrha** (*Pisonia aculeata*) (fig. 224), a large straggling shrub, armed with recurved axillary spines. "It makes excellent impenetrable fences, and when fairly caught in its trammels it is no easy matter to be extricated, the prickles being so numerous, strong, crooked, and sharp."—Roxburgh.

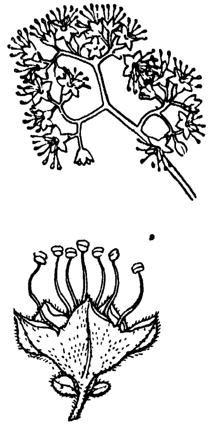


Fig. 224.—Bagh-anchrha, ♂ (*Pisonia aculeata*)

The flowers of **krishna-kali** mentioned above are AUTOGAMOUS, as the stamens and the style become rolled up together.

Nat. Order 2. *Amarantaceæ.*—Herbs or shrubs, erect or with climbing branches. Flowers hermaphrodite, sometimes unisexual, in simple or branched spikes or in heads (capitate). Bracts scarious or hyaline; bracteoles 2, scarious. Perianth inferior, dry, of 5 scarious persistent leaves. Stamens 1 to 5, opposite the perianth segments. Ovary 1-celled, superior. Fruit a membranous utricle, rarely berry. Seeds with black crustaceous shining testa, embryo horseshoe-shaped or annular, surrounding the floury albumen.

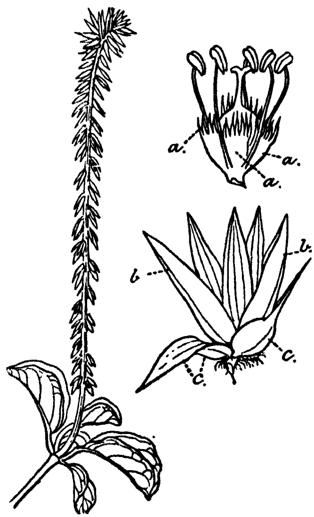


Fig. 225.—Apang (*Achyranthes aspera*) *a*, Staminodia. *b*, Sepals. *c*, Bracts.

Tropical and sub-tropical. Common plants:

Fig. 226 —Safed-(white) morug-phul (*Celosia argentea*)

kanta-nátia, **champa-nátia**, **nátia-shag**, and **dengo-danta**: all these belong to the genus *Amarantus*, which is monœcious, the first-named plant being a common spinous weed, and the rest cultivated as vegetables; **apang** (*Achyranthes aspera*) (fig. 225), a common roadside weed, the fruits of which separate easily and stick to the cloth of passers-by; **kháya-dáya** (*Pupalia atropurpurea*), a common weed of waste lands; **morug-phul** or Cock's Comb (*Celosia cristata*), commonly cultivated in gardens for its long, flat, handsome, pink, fasciated inflorescence; **safed-** (white) **morug-phul** (*Celosia argentea*) (fig. 226), which grows in barren soils, and bears a globose head of very pale-pink flowers which, as they mature, turn pure white —both the species of *Celosia* have circumcissile capsules (see fig. 141); **ghole-mouni** (*Deeringia celosioides*), a climbing shrub with spiked purple berries; **gul-mákhmal** (*Gomphrena globosa*) (fig. 227) is a herb, cultivated in gardens for its showy, velvet-red heads of flowers.

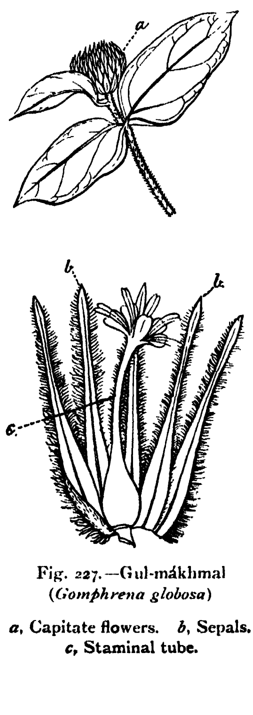


Fig. 227.—Gul-mákhmal (*Gomphrena globosa*)

a, Capitate flowers. *b*, Sepals. *c*, Staminal tube.

The presence of scarious bracts and bracteoles is a char-

acteristic mark of the family. The genus *Amarantus* is mostly ANEMOPHILOUS.

Nat. Order 3. *Chenopodiaceæ.*—Herbs or shrubs, sometimes fleshy. Leaves usually alternate, entire, membranous or fleshy. Flowers small, almost always green, hermaphrodite or unisexual. Perianth simple, inferior, sepaloid, of 3 to 5 segments. Stamens usually 5, opposite the perianth lobes. Carpels connate in a superior 1-celled ovary, often enclosed in the perianth base. Fruit a small membranous utricle or berry, generally enclosed in the perianth base. Seeds erect, sometimes albuminous.

Fig. 228.—Beto-shag (*Chenopodium album*)

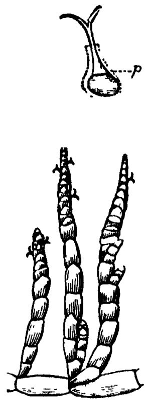


Fig. 229. — Jadu-palang (*Arthrocnemum indicum*)

p, Perianth, enclosing fruit.

Natives of all climates, in soils containing large amount of salt. Common plants: **puin** (*Basella rubra*), a much-branched, twining, fleshy herb, cultivated as a vegetable; **palang-shag** or Spinach (*Spinacia oleracea*), a succulent, erect, diœcious herb with a fusiform root, cultivated everywhere as a vegetable; **beet-palang** or Sugar-beet (*Beta vulgaris*), a herb with a large, napiform, red-coloured root, cultivated as a vegetable in this country and as a sugar-yielding crop in Europe; **beto-shag** (*Chenopodium album*) (fig. 228), a tall herb, also commonly cultivated; *Atriplex hortensis*, a cultivated herb; **jadu-palang** (*Arthrocnemum indicum*) (fig. 229), a

succulent herb with minute flowers sunk in the cavities of the joints of the fleshy stem. The flowers of *Chenopodium* are markedly protogynous.

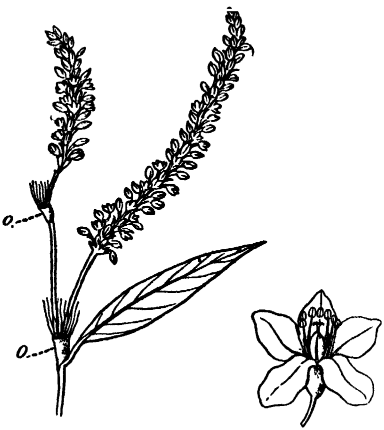


Fig. 230.—Pani-marich (*Polygonum barbatum*) *o*, Ochrea.

The flowers of this Order possess either a small, insignificant, greenish perianth or none. Insect visits are therefore rare, and the flowers are usually ANEMOPHILOUS or AUTOGAMOUS.

Nat. Order 4. *Polygonaceæ*. — Herbs, sometimes climbing, rarely trees. Leaves alternate. Stipules OCHREACEOUS. Flowers usually hermaphrodite, regular, small. Perianth simple, inferior, sometimes petaloid, segments 3 to 6, persistent. Stamens 5 to 8, opposite the perianth segments. Carpels connate, in a superior 1-celled usually TRIANGULAR ovary; style 3 or 2. Fruit, a small, hard, most often triangular nut, enclosed in the persistent perianth. Seeds erect, with copious albumen. The Order is chiefly tropical. Common plants: **pani-marich** (*Polygonum orientale*, *P. tomentosum*, *P. lanigerum*, *P. glabrum*, and *P. barbatum*) (fig. 230), common weeds in ditches and damp places; **ban-palang** (*Rumex maritimus*), a marsh weed with the persistent perianth segments having a white, tubercled mid-rib (fig. 231) and automatically self-

Fig. 231.—Ban - palang (*Rumex maritimus*)

pollinated flowers; **chuka-** (acid) **palang** (*Rumex vesicarius*), cultivated for its succulent acid leaves; *Antigonon leptopus*, a common garden climber with panicles of showy pink or white flowers and rachis often ending in a tendril; *Coccoloba platyclada*, cultivated for its flattened leaf-like stem (cladode) (see Plate I); Buckwheat (*Fagopyrum esculentum*), cultivated largely in England and Europe for its fruits, from which, as from wheat, bread is prepared; it is cultivated on a small scale in the Himalayas and the Khasi Hills. Species of *Rheum* or Rhubarb are cultivated as vegetables.

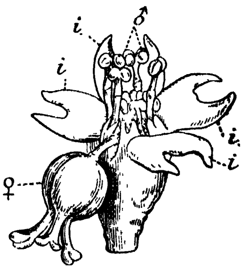


Fig. 232. –*Euphorbia*
i, Involucre.

Flowers, possessing a petaloid perianth, and aggregated in spiked or panicled inflorescence, are ENTOMOPHILOUS. Several species are dimorphic.

Nat. Order 5. *Euphorbiaceæ*. —Herbs, shrubs, or trees, often with milky or watery juice. Leaves usually simple; stipules usually small, caducous or persistent. Flowers usually small, minute, always unisexual. Inflorescence various: sometimes a cluster of one-stamened naked florets surrounds a solitary pistil, and the whole cluster is enclosed in a perianth-like involucre (CYATHIUM) (fig. 232); sometimes it is a dichotomous cyme. Perianth often small, simple, sepaloid; sometimes obsolete or wanting, rarely double. Stamens various; sometimes solitary, often indefinite; filaments free or connate in 1 or more bundles. Carpels usually connate into a 3-celled superior ovary, ovules 1 or 2 in each cell, pendulous from the inner angle of each cell; stigma usually consists of three bifid branches. Fruit usually a cap-

sule, dehiscing septicidally into 3 indehiscent COCCI; sometimes each of the latter dehisces loculicidally, scattering by the force of dehiscence the seeds to a great distance. Seeds albuminous, with or without aril at the hilum.

This is a large family, abounding in tropical countries. Common plants: **bharenda or aranda** or Castor-oil Plant (*Ricinus communis*) (fig. 233), a common erect shrub, sometimes tree-like, with alternate peltate palmately-lobed, simple leaves, and terminal racemose

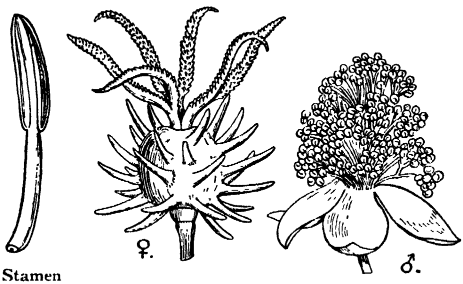


Fig. 233.- Castor Oil—Bharenda or rerhi (*Ricinus communis*)

panicles of androgynous monœcious flowers, stamens polyadelphous or in much-branched clusters, capsules dehiscing with explosion, and the seeds scattered to a great distance by the force of dehiscence; **lal-bharenda** or **sayambara** (*Jatropha gossypifolia*), **bag-bharenda** (*Jatropha Curcas*), both of which are common shrubs on roadsides or hedges, with monœcious flowers in dichotomous cymes, the central flowers being female and the male flowers monadelphous; the Coral Plant (*Jatropha multifida*), a common garden plant with red flowers in dichotomous cymes and digitately-multifid simple leaves; **teshira-monsha** (*Euphorbia antiquorum*), a common hedge plant with a succulent leafless spinous 3-angled irregularly-narrowed stem,

often named **baj-barán**, from its supposed power of acting as a lightning-conductor, it is a typical xerophyte in structure; **mánsha** or **mánsha-siju** (*Euphorbia nerifolia*), a tree sacred to Monsha, the goddess of serpents, with its stipulary spines and obovate fleshy glabrous leaves; *E. Nivulia* is another kind of **siju** (fig. 234); **lal-pata** (*Euphorbia pulcherrima*), a favourite garden plant cultivated for its showy scarlet-coloured leafy bracts; **rang-chita** (*Pedilanthus tithymaloides*) (see fig. 114), a common hedge plant with round green stems, thick glabrous, opposite, cordate

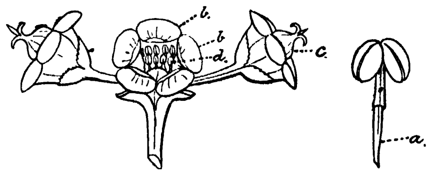


Fig. 234.—*Euphorbia Nivulia* (a kind of siju)
a, Single stamen with filament jointed to a pedicel. *b*, Involucre. *c*, Pistil. *d*, Stamen.

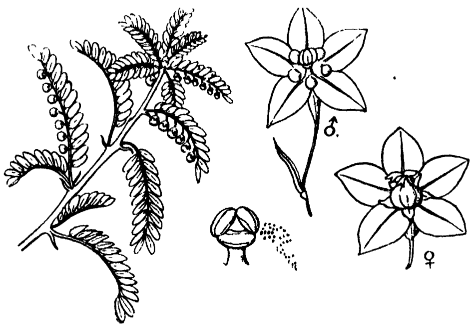


Fig. 235. -Phyllanthus Niruri (*bhuin-amla*)

leaves, and flowers in red boot-shaped cyathium; **amlaki** (*Phyllanthus Emblica*) and **norh** (*P. distichus*), common trees with distichous simple leaves, the branchlets with their leaves look like, and are often mistaken for pinnate leaves; some species of *Phyllan-*

thus are common roadside weeds (fig. 235); **pituli** (*Trewia nudiflora*) (figs. 236, 237), a deciduous tree with diœcious pollen-flowers; **bichuti** or **jal-bichuti** (*Tragia involucrata*), a perennial small twining herb with stems, leaves, and fruits full of stinging bristles, used by village schoolmasters as an instrument of castigating truant boys; **akrote** or Walnut (*Aleurites moluccana*) — not the English Walnut—a tree pretty common in gardens about Calcutta, originally a Malayan plant; Cassava or

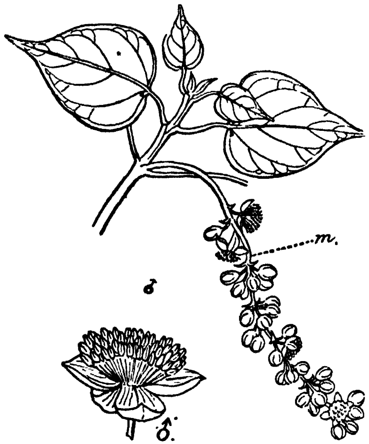


Fig. 236.—Pituli (*Trewia nudiflora*) ♂
m, Male spike or catkin.

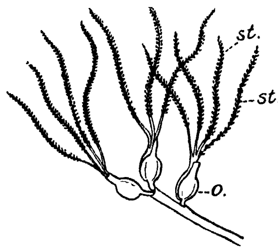


Fig. 237.—Pituli (*Trewia nudiflora*) ♀
st, Stigma. *o*, Ovary.

Tapioca (*Manihot utilissima*), a tall herbaceous plant with alternate large entire or digitate leaves and big tuberous roots, a native of South America, now largely cultivated in Bengal for its roots, which yield a kind of flour for making bread; **swet-basanta** (*Acalypha indica*) (fig. 238), a common erect annual weed of waste lands with the female flowers included in a campanulate green bract; the Indian Spurge (*Euphorbia hypericifolia*, var. *indica*), an annual weed with milky juice, small opposite simple leaves, and minute greenish flowers in a cyathium; *E. heterophylla* Linn., an

annual herb common in gardens, with the leaves embracing the cymes spotted scarlet near the base, but green towards the apex; Crotons, tropical shrubs with monœcious flowers commonly cultivated in gardens for their mottled green, yellow, and red leaves; **khirui** (*Euphorbia thymifolia*, *E. pilulifera*, *E. microphylla*), the common name of roadside prostrate weeds which are distinguished popularly as **swėt** or white **khirui**, **barha** or large **khirui**, and **chhota** or small **khirui**; *Homonoia riparia*, an evergreen shrub of rocky river beds.

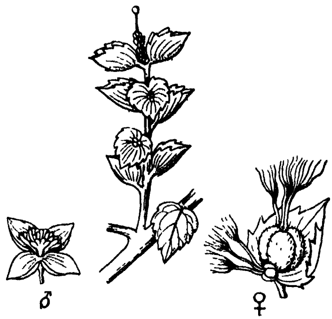


Fig. 238.—Mukta-jhuri or swet-basanta (*Acalypha indica*)

The genus *Euphorbia* (Spurges) has a characteristic inflorescence known as CYATHIUM. It is composed of many small male flowers, each consisting of a single stamen with a jointed filament, and a solitary female flower, consisting of a 3-celled ovary with a jointed pedicel, the flowers being enclosed in a 4- to 5-lobed cup-like, often coloured involucre, which beginners are likely to mistake for a perianth enclosing the stamens and the single pistil, as if the inflorescence were a single flower with a perianth, many stamens, and 1 pistil. This is apparent from a consideration of the fact that the stamens and the pistils have each a jointed stalk which in some allied genera is provided with a rudimentary or hairy perianth at the joint. The involucre has at its indentations glands which secrete exposed nectar. The flowers are PROTOGYNOUS. The 3 bi-lobed stigmas emerge first from the involucre,

then the long-stalked ovary projects beyond the involucre and droops down on one side of the latter. The stamens then mature, elongate one after another, and take up the position occupied by the stigmas at the first stage. Pollination is effected mostly by flies. *Pedilanthus* or **rang-chita** is closely allied to *Euphorbia* in the structure of the inflorescence and flower, but the involucre is boot-shaped and devoid of glands. It is also distinctly protogynous.

Euphorbia and *Pedilanthus* are amply provided with LATICIFEROUS vessels.

Nat. Order 6. *Urticaceæ.*—Herbs, shrubs, or trees, usually with a milky juice. Leaves often stipulate. Flowers usually small, greenish, unisexual, rarely bisexual. Perianth in one whorl, connate or free, inferior. Stamens equal in number and opposite to the perianth lobes. Ovary superior, 1- or rarely 2-celled, with one ovule in each cell. Seeds with or without albumen.

The distribution is chiefly tropical. As it is a large and composite family it is divided into several tribes, of which four, including some of the well-known Bengal plants, are mentioned here.

TRIBE URTICEÆ, including the genera *Fleurya*, *Bœhmeria*, &c. *Fleurya interrupta* is the well-known erect annual herb of waste places known by the Bengali name of **lal-bichuti**, a quite different plant from **jal-bichuti**. It has: male, calyx 4-leaved, corolla 0; and female, calyx connate and cup-shaped, corolla 0; stamens 4, inflexed in bud; ovary 1-celled, 1-ovuled. The Rhea or Chinese Grass (*Bœhmeria nivea*) is a shrub with herbaceous shoots, largely cultivated for its silky fibre known as rhea fibre. *Pouzolzia indica* is a marsh herb with samaroid fruit.

TRIBE CANNABINEÆ, including the genus *Can-*

nabis, &c. Hemp or **ganja** (*Cannabis sativa*) is a tall, erect annual with small diœcious flowers, males in axillary cymes, females in axillary racemes; stamens not inflexed in bud but straight. The leaves are used in preparing an intoxicating beverage known as **siddhi** or **bhang**. The young inflorescences are smoked as **ganja**, and the resinous exudation is also smoked as **charash**. The bark of the plant yields a valuable fibre known as Hemp. The Hop, a twining plant, which is largely cultivated in Europe for imparting flavour and a preserving quality to malt liquor, belongs to this tribe.

TRIBE ARTOCARPEÆ, including the genera of *Ficus*, *Artocarpus*, &c. The genus *Ficus*, to which belong Banyan or **bot** (*Ficus bengalensis*), Peepul or **aswathwa** (*Ficus religiosa*), **dumur** (*Ficus hispida*, *F. Cunia*, &c.), **pakurh** (*Ficus infectoria*), and India-rubber Tree (*Ficus elastica*), is characterized by a round, ovoid or jug-shaped hollow rachis or floral axis, lined internally by a crowd of small monœcious flowers. The inflorescence matures into a collective spurious fruit known as SYCONUS; the enclosed minute fruits or achenes are popularly mistaken for seeds. How the flowers are pollinated, and the seeds or fruits dispersed by birds, especially crows, has already been described. The fruits of *Ficus* resemble the fruit or Hip of the Rose, with this essential difference, that the Hip of the Rose is the product of a single flower, whereas the fruit of a *Ficus* is the product of an inflorescence or many flowers (see fig. 72). The genus *Artocarpus*, to which belong the Jack-fruit tree or **kantal-gachh** (*Artocarpus integrifolia*), **dalo, dao**, or **madar** (*Artocarpus Lakoocha*), and **chaplasha** (*Artocarpus Chaplasha*) of Chittagong and Tipperah, is characterized by a globose or oblong inflorescence,

having a solid axis (rachis) lined externally by a crowd of very small flowers, either only male or only female. The inflorescence matures into an aggregate spurious fruit known as SOROSIS (see fig. 135). *Artocarpus incisa*, the Bread-fruit tree, a native of the Pacific islands, with pinnifid leaves, is occasionally cultivated in India.

TRIBE MOREÆ, including the genera of *Morus*, *Streblus*, *Broussonetia*, &c., is characterized by stamens inflexed in the bud. Mulberry or **toont** (*Morus indica*) has diœcious flowers in long or short spikes; female perianth and bract accrescent, and succulent in the fruit. Fruit spurious, and consisting of achenes enclosed in accrescent bracts and perianths, and aggregated in spikes. It is largely cultivated for its leaves, which are used for feeding silkworms.

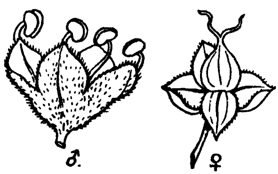


Fig. 239.—Shaorha (*Streblus asper*)

Paper Mulberry (*Broussonetia papyrifera*), a native of Burma, Malaya, and Polynesia, is planted occasionally. The fibrous bark of this plant is beaten out and worked up into a kind of cloth, and also a kind of paper. *Streblus asper* (**shaorha**) (fig. 239) is a rigid gnarled shrub, supposed to be the haunt of evil spirits. It has diœcious flowers with inflexed stamens, which on the slightest touch jump up and scatter a cloud of powdery pollen-grains.

Nat. Order 7.—*Juglandiaceæ* includes the English Walnut tree (*Juglans regia*), a native of Persia and the Himalayas; *Engelhardtia spicata* (fig. 240), a handsome tree of Khasi Hills and Chittagong, with its fruit adnate to the 3-lobed bract.

Nat. Order 8.—*Cupuliferæ* includes the Oak tree (*Quercus*), the Beech tree (*Fagus*), and the Chestnut

tree (*Castanea*) of Europe. *Betula edulis* is the **bhurya-patra** of the Himalayas, its bark peels off in horizontal plates or flakes. *Quercus spicata* (fig. 241) is a kind of Oak found in Assam and Chittagong.

Fig. 240.—Bolas (*Engelhardtia spicata*)
b, Persistent bracts.

Nat. Order 9.—*Casuarinaceæ* includes **jhau** or Beef-wood tree (*Casuarina equisetifolia*), a big tree planted usually in avenues; the tree has a striking resemblance to the Pine tree, and is practically leafless; the fibrous,

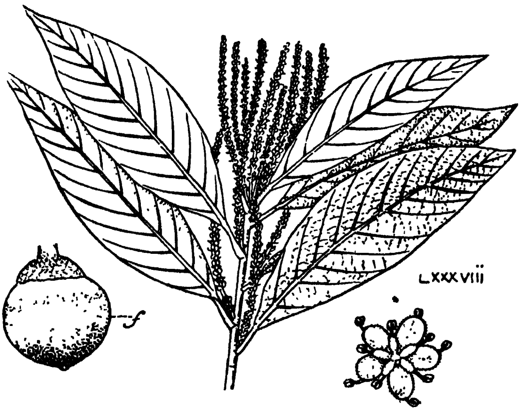


Fig. 241.—Chota-chakma (*Quercus spicata*), a kind of oak
f, Fruit (acorn).

grooved, jointed, green, so-called leaves are really jointed branches (cladodes) bearing a whorl of minute

connate scale-leaves at each of the joints or nodes, and resembling the branches of *Equisetums*, hence the name. This **jhau** is a quite different plant from the dwarf shrubby **jhau** (*Tamarix*) of sand-banks.

Nat. Order 10.—*Salicaceæ* includes the Willow (*Salix*) and Poplar (*Populus*) of Europe. *Salix tetrasperma* (fig. 242) is a small tree met with here and there.

Fig. 242.—Pani-jom (*Salix tetrasperma*)

Nat. Order 11.—*Santalaceæ* includes **chandan** or Sandal-wood tree (*Santalum album*), which is a root-parasite, sucking its food from the roots of its hosts, though not wholly dependent on them (though the growth is certainly affected in the absence of the host plants).

Nat. Order 12.—*Balanophoraceæ* is a family of leafless parasites, of which *Balanophora dioica* (fig. 243) is met with in the Khasi Hills.

Nat. Order 13.—*Myristicaceæ* includes **jay-phal** or Nutmeg tree (*Myristica fragrans*), the seeds of which are the Nutmeg or **jayphal** of commerce, and the laciniated scarlet aril of the seed is the **jaitri** or Mace of commerce (see fig. 124).

Nat. Order 14.—*Lauraceæ* includes **dalchini** or Cinnamon tree (*Cinnamomum zeylanicum*), in which valvular dehiscence of the anthers, a character of the

Order, is well-marked (as in *Berberidaceæ*). The bark forms the cinnamon of commerce. **Akas-bael** (*Cassytha filiformis* (fig. 244) is a leafless, thready, greenish parasite.

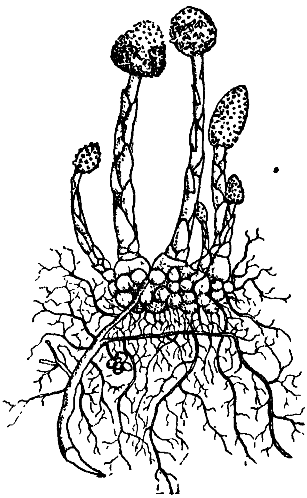


Fig. 243.—*Balanophora dioica*

Nat. Order 15.—*Aristolochiaceæ* includes **ishermul** (*Aristolochia indica*) (see fig. 116), a common climber, the roots of which are supposed to frighten away snakes, the flowers being distinctly protogynous with pitfall arrangement (see Chapter XVII). Gynandrous stamens and inferior ovary form distinctive characters of the Order.

Nat. Order 16.—*Loranthaceæ*, a parasitic family, includes **barha-** (large) and **chhota-** (small) **manda**

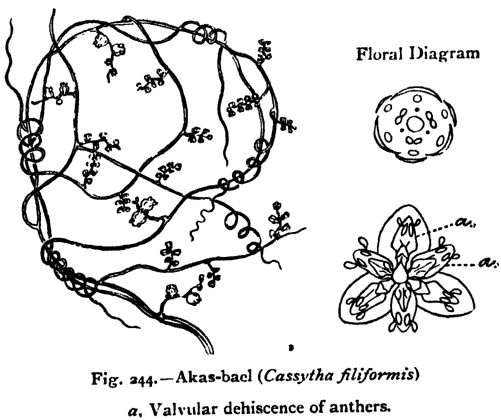


Fig. 244.—Akas-bael (*Cassytha filiformis*)

a, Valvular dehiscence of anthers.

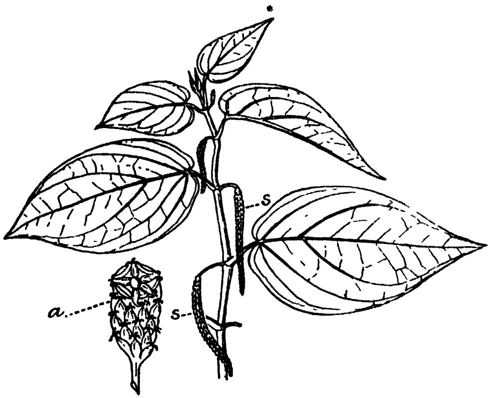


Fig. 245. Piper Betle (*pan*) or Betel Vine

a, Enlarged female spike. *s*, Spike (catkin).

(*Loranthus longiflorus* and *L. globosus*), common on Mango and other trees, and the well-known English parasite Mistletoe (*Viscum*).

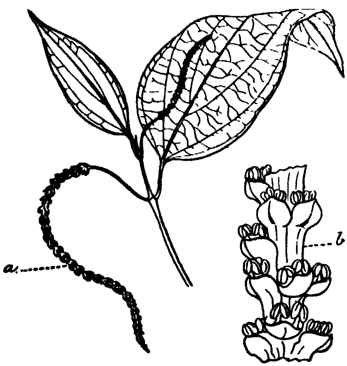


Fig. 246.– Kabab-chini (*Piper caninum*)

a, Male catkin. *b*, Enlarged catkin ♂.

Nat. Order 17. *Piperaceæ*. — Shrubs erect, scandent or twining; branches with swollen nodes. Leaves entire, often oblique. Flowers usually diœcious, in spikes. Perianth 0. Stamens 2 to 4. Ovary usually 1-celled. Fruit a 1-seeded berry. Embryo surrounded by both endosperm and perisperm.

Chiefly tropical. Common plants: **pan** or Betel Vine (*Piper Betle*) (fig. 245), a stout climber, cultivated largely for its leaves, which are used as a mas-

ticatory; **chai** (*Piper Chaba*), also a stout climber, the wood of which is used as a pungent condiment; **pipool** or Long Pepper (*Piper longum*), a slender creeper; **gol-marich** or Black Pepper (*Piper nigrum*), also a climber; **kabab-chini** is *Piper caninum* of Java, a kind of **marich** used with **pan** for its volatile

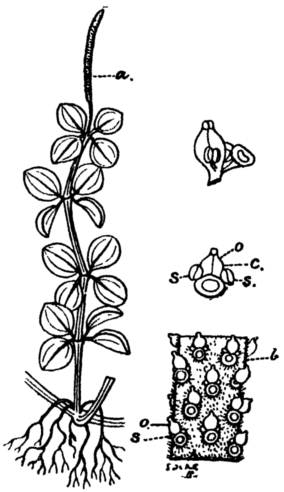


Fig. 247.—*Peperomia reflexa*

a, Spike. *b*, Spike enlarged. *c*, One flower. *o*, Ovary. *s*, Stamen.

Fig. 248.—*Houttuynia cordata*

f, Spike with a whorl of four white bracts (*b*) at its base.

oil (fig. 246). *Peperomia reflexa* (fig. 247) is a common herbaceous tufted weed of waste lands. *Houttuynia cordata* (fig. 248) is an erect herb of waste lands in the Khasi Hills, having a spike with four big white bracts below it, which may be mistaken for the perianth.

Piperaceæ are characterized by an abnormal struc-

ture of the wood, which is more of the Monocotyledonous type.

Class 2.—MONOCOTYLEDONS

Sub-class I. PETALOIDEÆ

Series 1.—*Hypogyneæ: Ovary superior*

Nat. Order 1. *Liliaceæ.*—Herbs, rarely shrubs, with fibrous roots, or a creeping root-stock, or a bulb, or a corm. Leaves cauline or radical. Flowers usually hermaphrodite, solitary or in clusters; bracts small, scarious or spathe-like. Perianth petaloid, inferior, usually 6-merous, in two series. Stamens 6, hypogynous, free. Carpels 3, connate in a superior 3-celled ovary, with 2 or more ovules in each cell. Fruit a capsule or berry, usually 3-celled. Seeds with albumen. The Order is both tropical and temperate. Common plants:

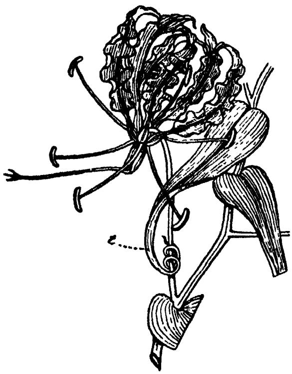


Fig. 249.—Ulat-chandal (*Gloriosa superba*)

t, Leaf-apex tendril.

Onion or **pianj** (*Allium Cepa*); Garlic or **rasun** (*Allium sativum*), and the Indian Leek (*Allium tuberosum*), all cultivated for their edible bulbs; **ulat-chandal** (*Gloriosa superba*) (fig. 249), which climbs by the tendrils terminating the leaf-blades, and bears superb flowers; **sata-moolee** (*Asparagus racemosus*) (fig. 250), which has fascicles of tuberous roots, thorny, climbing, much-branched stems, minute scaly leaves, the lower half of each of which is transformed

into a spine, with tufts of axillary, needle-like cladodes (see fig. 56); another species of *Asparagus* is cultivated for its young shoots, which are much esteemed as a vegetable; **murga** or **mugra** or Indian Bow-string Hemp (*Sansevieria zeylanica*, Willd.), a perennial herb with a rosette of large, linear, fleshy, rigid, concave, sharp-pointed leaves, 1 to 4 feet long, which yield a tenacious fibre; **ghrita-kumari** or Aloe (*Aloe perfoliata*), a common herb, with sword-shaped, erect, dentate, fleshy leaves, 1 to 1½ feet long, from which a mucilage known as Aloe is prepared, is an African plant naturalized in this country, and quite different from the American Aloe (*Agave*, belonging to the Nat. Order *Amaryllidaceæ*); *Dracæna* and *Yucca*, common arborescent shrubs of our gardens, characterized by secondary thickening of the wood (exceptional in Monocotyledons) and by possession of concentric bundles; **kumarika** or Sarsaparilla (*Smilax macrophylla*) (see fig. 60), a prickly climber, with net-veined leaves (exceptional in Monocotyledons), climbing by means of stipular tendrils, resembling very much the Yams (*Dioscorea*) in appearance and habit, specially in net-veined leaves, but differing from the latter in having superior ovary; the leaves of *Phormium tenax*, a native of New Zealand, yield a valuable fibre known as New Zealand Flax. The genus *Lilium*, after which the family is named, is widely spread in the North Temperate Zone, and forms a conspicuous feature of the landscape. This genus has nothing to do with the Water-lily and the other so-called Lilies of this country,

Fig. 250.—Sata-moolee (*Asparagus racemosus*)

which are no Lilies at all. *Disporum pullum* (fig. 251) is an erect annual herb of the Pareshnath Hills.

The pollination in *Gloriosa* and *Yucca* is an interesting study. In the bud state the *Gloriosa* flowers are drooping, with the perianth folded over the stamens and pistil. When the flowers open, the perianth-lobes curl upwards, exposing the stamens and pistil directed downwards, the stamens bending at right

Fig. 251.—*Disporum pullum*

angles to the floral axis project beyond the circumference of the flower, and the pistil stands with the ovary straight in the middle of the flower, but the style is bent at an acute angle upon the ovary, so as to reach the circumference of the flower and to be amongst the stamens. But as the style is longer than the filaments, the stigma projects beyond the reach of the anthers. The pollen-grains have thus no chance of falling upon the stigma. Insects, especially butterflies, attracted by the superbly-coloured perianth and honey secreted in its grooves, visit them, and effect

Fig. 252.—Transport of Pollen by Egg-laying Insects

1, Branch from the inflorescence of *Yucca Whipplei*; the middle flower open, that beneath it was open the previous night and is now closed again, the rest of the flowers in bud. 2, Single flower of the same plant visited by a moth of the species *Pronuba yuccasella*; the three front perianth-leaves removed. 3, Stigma of *Yucca Whipplei*. 4, *Pronuba yuccasella* flying to a flower of *Yucca Whipplei*. 5, Head of *Pronuba yuccasella* with a ball of pollen held by the coiled maxillary palp. 1, 2, 4, Nat. size. 3, × 2. 5, × 20.

pollination. The slender style, however, on close inspection, is found slowly to move in a circle as if in search of the anthers, and may thus be self-pollinated if cross-pollination fails. Such provision for self-pollination in case cross-pollination fails is met with in several flowers.

In the conspicuous white flowers of *Yucca*, Yucca-moths have been found to stuff pollen-grains into the stigmas of all the capsular species, in order that the larvæ hatched from the eggs deposited by the moths inside the ovary in the neighbourhood of the ovules may receive the nourishment necessary for their sustenance (fig. 252).

The petaloid perianth often makes the flowers conspicuous, as in *Gloriosa* and *Yucca*. When the flowers are small they are rendered conspicuous by being aggregated together in close racemes and umbels.

Nat. Order 2. *Commelinaceæ*.—Herbs prostrate or erect. Leaves with prominent sheath. Flowers more or less irregular, hermaphrodite or polygamous, often enclosed in spathaceous bracts. Perianth inferior, 6-leaved in two series, the outer sepaloid and the inner petaloid. Stamens 6 to 8, all perfect, or some abortive; filaments often bearded with moniliform (bead-like) hairs. Carpels usually 3, connate in a 3-celled superior ovary. Ovules solitary or few. Fruit a capsule or indehiscent. Seeds angled, albuminous.

Chiefly tropical. The common plants are all weeds of moist and waste places, such as **jata-kanshira** or **dholapata** (*Commelina benghalensis*) (see fig. 103), a very common weed of ditches and other moist places, with two kinds of flowers, one kind aerial, with the inner perianth beautifully blue, another cleistogamous, buried under the ground (see Chapter XVI);

kanshira (*Commelina appendiculata*), also a common weed in ditches; other species of *Commelina*, which are also similar weeds; *Aneilema spiratum*, *A. vaginatum*, and *Cyanotis axillaris* are common field-weeds. *Tradescantia*, an American genus, presents marked differences from the Monocotyledonous type in its vascular system. The hairs on the filaments of the stamens of *Tradescantia virginica* are interesting as showing circulation of protoplasm. Some species of *Tradescantia* are common in our gardens. The hairs on the filaments of *Cyanotis axillaris* also show circulation of protoplasm. Compare with this circulation or irregular motion of the ·protaplasm the rotation or regular motion of the protoplasm met with in *Vallisneria* and *Chara*.

Fig. 253.—*Juncus bufonius*

Nat. Order 3. *Juncaceæ*.—These are plants which approach the *Graminaceæ* in their grass-like aspect and glumaceous perianth, and the *Liliaceæ* in the structure of their flowers. The leaves are either cylindrical, or flat and linear, or reduced to mere sheaths. The plants commonly grow in ditches and wet places, and go by the name of Rushes (*Juncus*), one or two species of which are commonly seen everywhere (fig. 253). The Order bears ANEMOPHILOUS flowers. Self-pollination is usually prevented by PROTOGYNY. CLEISTOGAMY sometimes occurs. Closely allied to it is the Nat. Order *Eriocaulaceæ*, which have a grass-like aspect, monœcious flowers, and are common weeds in rice-fields.

Nat. Order 4. *Alismaceæ.* — Aquatic or marshy plants with radical leaves and panicled or umbellate inflorescence in scapes. Flowers 1- or 2-sexual. Perianth inferior, segments 6, 3 outer sepaloid and herbaceous, 3 inner petaloid. Stamens 6, 9, or indefinite. Pistil of 3, 6, or more carpels, apocarpous, superior. Ovule 1 or more in each carpel. Fruit a cluster of achenes or follicles. Seeds minute.

Fig. 254.—*Alisma Plantago*

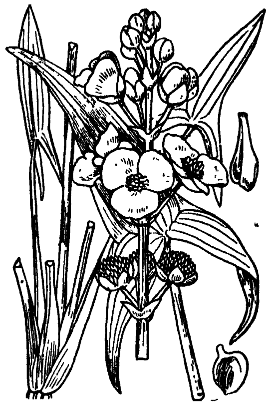


Fig. 255.—Chota-kat (*Sagittaria sagittifolia*)

This family represents the family of *Ranunculaceæ* among the Dicotyledons in having the pistil apocarpous and multiple, and innumerable hypogynous stamens. The Order is cosmopolitan. The common plants are three or four species of *Alisma* (fig. 254), with lanceolate, cordate, or sagittate leaves, hermaphrodite flowers, and solitary ovules; one species of *Limnophyton*, with sagittate erect leaves, milky juice, polygamous flowers, and solitary ovules; two species of *Sagittaria* (fig. 255), with long-petioled, sagittate or elliptic-cordate leaves, unisexual flowers, and solitary ovules; and *Butomopsis lanceolata*

(fig. 256), a common herb of marshes and rice-fields, with elliptic-acute radical leaves, milky juice, hermaphrodite flowers, and many ovules scattered over the inner wall of the carpels (superficial, *s. p.*). The perianths are petaloid and serve to attract insects.

Nat. Order 5. *Naiadaceæ.*—Scapigerous marshy herbs, either submerged or floating, with elongated branched stems. Flowers hermaphrodite or unisexual, green and inconspicuous, in spikes, racemes, or spadices. Perianth 0, or 4-parted, inferior. Stamens 1 to 6. Pistil of 1 to 6 carpels, apocarpous. Fruit achenes, follicles, or drupes. The Order is temperate and tropical. Common plants: Pond Weed or *Potamogeton indicus* has small green 2-sexual flowers in scapes rising from a spathe, perianth of 4 segments; carpels 4, 1-ovuled; floating leaves large, coriaceous; submerged leaves longer, narrower, and membranous. *P. crispus* (fig. 257) is a pond-weed with oblong crisped leaves. This family agrees with the *Spadicifloræ* in some respects, and is therefore sometimes included in that sub-class.

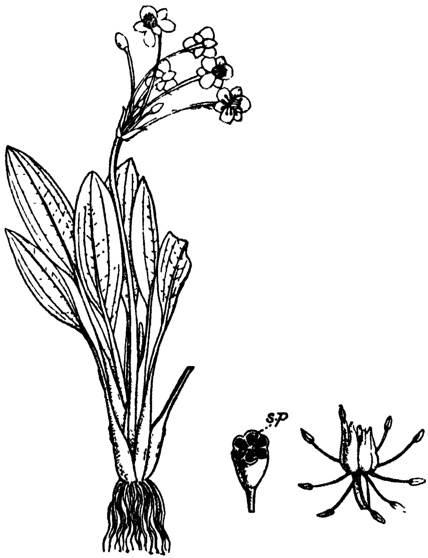


Fig. 256.—*Butomopsis lanceolata*

s. p., Superficial placentation.

Nat. Order 6. *Pontederiaceæ.*—Marsh herbs or fresh-water aquatics of the habit of *Alismaceæ*, flowers like those of the latter, with this difference, namely, the pistil consists of 3 carpels, syncarpous, forming a 3-celled ovary. The Order is tropical. *Monochoria hastæfolia* and *Monochoria vaginalis* are two species very common in marshy places and shallow tanks in Calcutta and the neighbourhood. *Eichornia crassipes* or Water Hyacinth (see Plate III) was hardly known in and about Calcutta a few years ago, but now it has overspread all marshes and tanks with its large broadly ovate or cuneate deep-green glabrous and coriaceous leaves, which float by the help of the swollen end of the petiole and grow so thickly as to completely cover the water. The spiked scapes with pale-blue or purple flowers (Plate VII, fig. B) are seen from a great distance to rise above the surface of the water and form a conspicuous feature of the scenery. When it spreads over flowing rivers it impedes navigation seriously. It is a Brazil plant, and has been called Water Hyacinth, though it has nothing to do with the true Hyacinth.

Fig. 257.—*Potamogeton crispus*

Series 2.—*Epigyneæ: Ovary Inferior*

Nat. Order 7. *Amaryllidaceæ.*—Similar to *Liliaceæ*, from which it differs in having an inferior ovary.

A large family widely distributed but chiefly in dry sunny climates. Common plants: **rajani-gandha** or

Indian Tuberose (*Polyanthes tuberosa* Willd.), seen only in gardens, where both the single and double varieties flower in the rains; *Furcræa gigantea* Vent., a short-stemmed large shrub, radical leaves tufted, fleshy, with spinous tips and edges, unarmed or slightly armed; *Agave Cantula* Roxb. (fig. 258), the American Aloe, an almost stemless shrub, radical leaves tufted, large, fleshy with spiny tips and spinous serrate edges, commonly used as a hedge plant like the last—the leaves of both these plants yield a strong coarse fibre; *Crinum asiaticum* (fig. 259), a bulbous herb common in gardens, with long smooth radical leaves and large umbels of regular white flowers; *Crinum latifolium* (**sukha-darshan**), also a common garden herb, with white flowers more or less streaked with red or purple nectar-guides; *Pancratium verecundum*, also a similar garden herb, with flowers having a membranous corona uniting the filaments at the base. *Hypoxis aurea* is a small weed with tubercled seeds. *Curculigo orchioides* is a small herb with blue flowers.

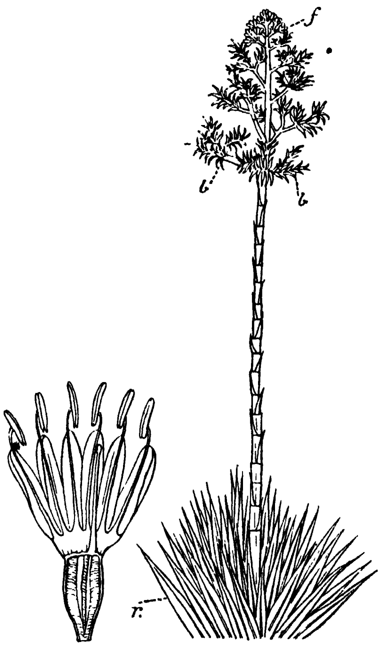


Fig. 258.—*Agave Cantula* (a kind ot *murga*)
f, Flower. *b*, Bulbils. *r*, Radical leaves.

The Order possesses many species, with homogamous bee-flowers.

Agave Furcræa and most other *Amaryllideæ*, as well as *Sanseviera* and *Aletris* among *Liliaceæ*, are good examples of XEROPHYTES with their thick succulent leaves clothed with a thick epidermis.

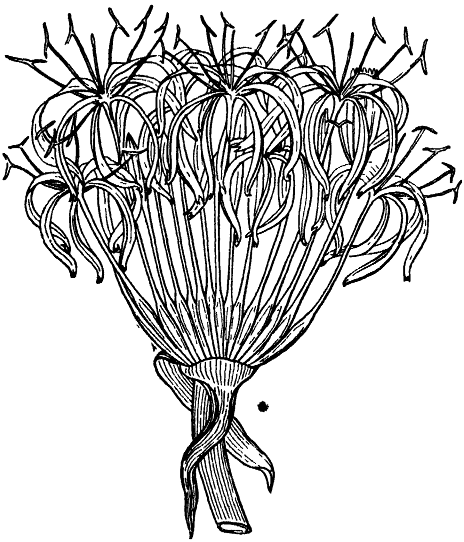


Fig. 259.—*Crinum asiaticum*

Nat. Order 8. *Iridaceæ.*—Similar to *Amaryllidaceæ*, from which it differs in having 3 stamens instead of 6. This is a large temperate and S. African family, unimportant in India and the tropics generally. Common plants: **dasbai-chandi** (*Belamcanda chinensis*), common in gardens all over India, blossoms in the rains and ripens its seeds in the cold season; **jafran** or **saffron** (*Crocus sativus*) (fig. 260) is a Cashmere plant, the dried styles and stigmas of which yield the **jafran**

or **saffron** of commerce. *Iris nepalensis* (fig. 261) is a bulbous herb of Nepal and the Khasi Hills.

The brightly-coloured perianth, and often the petaloid styles, make the flowers conspicuous to butterflies and bees which visit them.

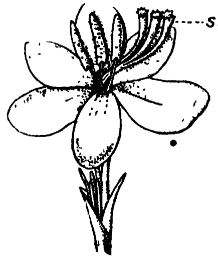


Fig. 260.—*Crocus sativus*, var. Cashmerianus

st, Petalled stigma.

Nat. Order 9. *Dioscoreaceæ.*—Climbing plants with fleshy tuberous root-stocks, which are sometimes epigeal. Leaves reticulate (as in Dicotyledons), petiole often angled. Flowers small, unisexual, diœcious or monœcious in separate spikes. Perianth 6-partite, 2-seriate, superior. Stamens 6, epigynous. Ovary inferior, 3-celled, styles 3. Ovules 1 to 2 in each cell. Fruit a loculicidal capsule or berry. Seeds with albumen. The Order is chiefly tropical. Common plants: Yams or **chupri-** or **kham-**, or **sakar-kanda-aloo**, which belong to the different species of the genus *Dioscorea*, such as *Dioscorea alata*, *D. alata*, var. *globosa*, &c. Observe the minute green bulbils often borne in the axils of the leaves of *Dioscorea* and the three-cornered or winged fruits of some of them. *Stemona tuberosa* is a common big climber.

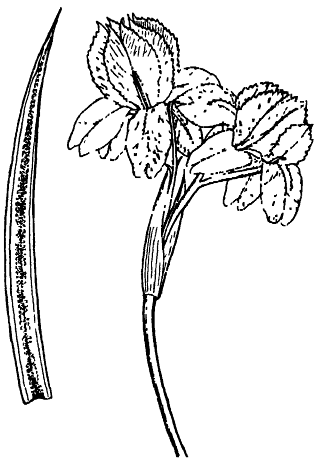


Fig. 261.—*Iris nepalensis*

The climbing habit and reticulate leaves relate this family to the genus *Smilax* of *Liliaceæ*, from which it is distinguished by the possession of an inferior ovary.

Nat. Order 10. *Scitamineæ.*—A large family, almost exclusively tropical, divided into three sub-orders, namely:

1. *Zingiberaceæ.*—Herbaceous perennials with rhizomes or bulbs, and broad simple leaves having sheathing bases with or without petioles, pinni-veined. Flowers irregular, in spikes or racemes with spathaceous bracts; perianth 2-seriate, superior; outer segments 3, calycine, sometimes spathaceous; inner segment 3, more or less petaloid. Stamens 1 perfect and 5 sterile, of which all or some are converted into petal-like staminodia which are apt to be mistaken for petals. Ovary inferior, 3-celled. Fruit a loculicidal capsule or berry. Seeds often with both perisperm and endosperm (vitellus). The Order is chiefly tropical. Common plants: **ada** or Ginger (*Zingiber officinale*), the dried rhizomes of which yield the Ginger or **shoont** of commerce; **ban-** (wild) **ada** (*Zingiber Casumunar*); **halood** or Turmeric (*Curcuma longa*), the dried rhizomes of which are largely used as a colouring material in cooking; **ban-** (wild) **halood** (*Curcuma aromatica*); **am-ada** (*Curcuma Amada*), the rhizomes of which have the smell of mango, for which they are used as a flavouring substance; **bhuin-champa** (*Kæmpferia rotunda*); **dulal-champa** (*Hedychium coronarium*) (fig. 262), a highly-scented white-flowered garden annual; **alach** or Cardamom (*Amomum aromaticum*), a garden plant which seldom flowers or fruits in Bengal; *Alpinia Galanga*, a common garden plant with scented flowers; various species of *Globba* common in marshy places and river-banks, with terminal panicles, the lower flower-buds

of which are converted into bulbils, as in *Globba bulbifera* (see fig. 23). Some species of *Curcuma*, as

Fig. 262.—Dulal-champa (*Hedychium coronarium*)

st, Staminodia. *s*, Style and stigma taken out of the groove of the anther. *a.s.*, Anther embracing stigma and style.

sathi (*Curcuma zeodoria*), yield an inferior kind of Arrowroot. *Gastrochilus longiflora* is a stemless herb of Chhota Nagpur.

2. *Marantaceæ* or *Cannaceæ*.—Similar to *Zingiber-*

aceæ with the following points of difference, namely, the single perfect stamen has a petaloid filament,

Fig. 263.—Sarba-jaya or Indian Shot (*Canna indica*)

ca, Calyx. *co*, Corolla. *st*, Staminodia. *an*, Anther lobe. *sty*, Style.

and one anther-lobe fertile and the other lobe petaloid. Seeds with endosperm only. The Order is tropical. Common plants: Arrowroot (*Maranta arundinacea*), the bulbs of which yield starch known in commerce as Arrowroot: **sarba-jaya** or Indian Shot

(*Canna indica*) (fig. 263), which runs wild, and is also cultivated for its showy flowers; **sital-pati** (*Clinogyne dichotoma*) (fig. 264), a shrubby leafy cane-like plant of Chittagong the split stems of which are woven into mats known as **sital-pati.**

Both *Zingiberaceæ* and *Marantaceæ* flowers are rendered conspicuous by their brightly-coloured petaloid staminodia, one of which is usually large and more brightly coloured than the rest, and serves as a platform for the visiting butterflies and bees. This large staminodia is named the LABELLUM or LIP.

Fig. 264.—Sital-pati (*Clinogyne dichotoma*)

3. *Musaceæ.*—Herbaceous plants, often of great size. Leaves very large, petioles long and thick, with air-chambers, big concave sheaths, which successively overlap and form a spurious stem. Flowers in spikes with large spathaceous bracts, stamens 5, ovary and fruit as in Sub-orders 1 and 2. Seeds with mealy endosperm. The Order is tropical. Common plants are the various kinds of **kala** or Plantain or Banana, belonging to the genus *Musa*, in which the sepals form a 3- to 5-lobed spathaceous calyx, and the petals join together to form a unilateral corolla enclosing the stamens and the style. The fibres of *Musa textilis*, a Malayan plant, yield Manilla Hemp of commerce.

The Traveller's Tree, belonging to the genus *Ravenala*, a small tree with distichous plantain-like leaves, is a native of Madagascar, and is often planted in our gardens.

Nat. Order 11. *Orchidaceæ.*—Herbs, usually epiphytic in the tropics and terrestrial in the temperate regions: the epiphytes with their perennial stems or branches variously thickened and often forming a pseudo-bulb; the terrestrial forms often tuberous-rooted with annual herbaceous leafy or leafless flowering shoots. Flowers usually showy, hermaphrodite, and irregular. Perianth superior, of 6 petaloid segments in 2 whorls; the 3 outer segments nearly equal, of the 3 inner segments the 2 lateral ones equal, and the central one larger than the other two, and known as the LABELLUM or LIP; the labellum is normally posterior but rendered anterior by the twisting of the ovary. It is to the varying size, form, and colour of the perianth-segments that the striking character of the Orchid flowers is due, many of them simulating the appearance of insects, such as bees, butterflies, &c., or assuming other strange forms. Stamen usually 1; the filament of the stamen adheres to the style (gynandrous), forming together the COLUMN or GYNOSTEMIUM, which rises from the top of the ovary and terminates in a beak known as the ROSTELLUM, above which lies the single anther with usually a pair of pollinia, their caudicles ending in sticky disks or glands known as the RETINACULUM. The rostellum is merely the projecting portion of the stigma hanging over and concealing the receptive portion of it. Ovary inferior, usually twisted, 1-celled with 3 parietal placentas bearing a large number of very minute ovules; stigma usually discoid and glutinous, situated beneath the rostellum and facing the labellum. Fruit a

3-valved loculicidal capsule. Seeds extremely minute, exalbuminous, with a minute undifferentiated embryo.

This is a large family of wide distribution. Cool and moist regions, especially shady forests, are their favourite grounds. They are abundant in the cool, moist, hilly forests of Assam and Darjiling. In the epiphytic species the cortex of the root is covered with a special epidermis called the VELAMEN, which is several layers of cells in thickness, and thus facilitates the absorption and conduction of water-vapour as well as rain and dew (an instance of adaptation to environment). The Orchids are distinguished by a greater variety of flower-forms than any other family of plants, and these forms are adapted in a remarkable way for cross-pollination, so much so that the structure of a flower corresponds in its smallest details to the peculiarities of the form of its insect-visitor. Automatic self-pollination is usually excluded by the relative position of the stigma and the anther. The flowers are pre-eminently bee-flowers.

A bee, attracted by the bright-coloured perianth, comes and sits on the labellum as on a platform, and directed by the nectar-guides moves towards the opening of the perianth-tube leading to the honey concealed in the spur of the labellum. In so doing its forehead comes in contact with the rostellum, which is so fragile that it breaks, and the pollinia together with the retinaculum fall off from the anthers and stick to the forehead of the bee (see figs. 102, 110). By the time the bee, leaving the flower after sipping its honey and taking the load of pollinia on its forehead, comes to sit on the labellum of another flower, the pollinia on its forehead, by the bending of the caudicles, point exactly towards the receptive stigma of the second flower, and touch the latter as the bee

tries to enter the flower, and pollinate it. The stigma is so sticky that it holds the pollinia fast, and, overcoming the pulling force of the bee, separates them from the head of the insect, or at any rate ruptures the fine thrêads which bind the pollen-grains into masses, and retains some of the pollen-grains if not the whole pollinia. If the caudicles did not bend, the pollinia brought from the first flower would have touched the rostellum of the second flower and not the stigma, and the pollination would thus have been impossible. Leaving the pollinia or portions of them attached to the stigma of the second flower, it carries on its forehead a fresh load of pollinia from the latter flower and takes them to the third flower, and so on from flower to flower. Though cross-pollination is the rule in the family, self-pollination is by no means uncommon.

Fig. 265.—Rasna (*Vanda Roxburghii*)

a.r., Aerial root.

Common plants: **rasna** (*Vanda Roxburghii*) (fig. 265), an epiphytic herb with leafy stem, common on Mango and other trees in nearly every province; **swet-huli** (*Zeuxine sulcata*), an erect terrestrial grass-looking herb in open grassy plains all over Bengal.

Nat. Order 12. *Hydrocharidaceæ*.—This is a family of aquatic herbs with floating or submerged opposite

or whorled leaves, and usually diœcious flowers with inferior ovary. The family is especially noticeable for **pata-shaola** (*Vallisneria spiralis*) (see fig. 108), a stoloniferous weed, rooted in the mud of our tanks and ditches, with long, linear, radical leaves which are commonly used for refining **gurh** or crude sugar into white sugar. The submerged female flowers are supported on spirally-twisted stalks and the male flowers on short stalks among the leaves. At the time of pollination the submerged male flowers, breaking away from the short stalks, come to the surface of the water and float about. The female submerged flowers, unrolling their twisted stalk, also come to the surface at the same time and get pollinated by the freely-floating male flowers. When the pollination is over, the long stalk of the female flowers, twisting spirally again, pulls the flowers down under the water, where the fruits develop. The leaves of this plant are well adapted to show rotation of protoplasm. *Hydrilla verticillata*, a kind of **jhangi**, is a very common weed of our tanks with branching, floating stems and 3- to 4-nately-whorled leaves. Roxburgh says of this plant: "When the male flowers are ready to expand, the spathe bursts, the flowers are then quickly detached and swim remote from the parent plant on the surface of the water in search of the female flowers, resting on the extremities of the reflexed leaves of the perianth. What a wonderful economy!" The female flowers, in fact, remain

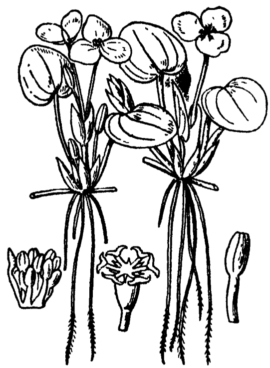


Fig. 265.—*Hydrocharis Morsus-Ranæ*

attached to the parent, as in *Vallisneria*, and possess a calyx-tube elongated into a thread, and the three filiform stigmas projecting out of the calyx-tube get easily pollinated by the freely-floating male flowers. *Lagarosiphon Roxburghii* (**rasna jhangi**) is a filiform tank herb. The mode of its pollination has already been mentioned. *Hydrocharis Morsus-Ranæ* is a floating herb with monœcious flowers (fig. 266). *Ottelia alismoides* is a marsh herb with white flowers and ovoid fruits enclosed in a 6-winged spathe.

This is mostly an Order of aquaphilous plants.

Sub-class 2. SPADICIFLORÆ

Nat. Order 1. *Palmaceæ.*—Shrubs or trees, solitary or gregarious. Stems usually unbranched, erect, sometimes climbing or trailing. Leaves large, sheathing at the base. Flowers 1- or 2-sexual, in an unbranched or branched spadix, enclosed in 1 or more spathes. Perianth inferior, of 6 segments in 2 whorls. Stamens usually 6, occasionally 3 or more than 6, hypogynous. Ovary superior, apocarpous or syncarpous, 1- to 3-celled. Fruit nut-like or baccate or drupaceous. Seeds with a minute embryo in a superficial cavity in the fleshy or horny endosperm.

This is a very large family, chiefly tropical, a few only extending into the temperate regions. With the exception of the Grasses this is perhaps the most valuable of all the families of plants, furnishing us with a vast variety of useful products, such as sugar, starch, oil, edible fruits and seeds, beverages, building and thatching materials, fibres, cordage, writing materials, and so on.

Common plants: **narikel** or Cocoa-nut (*Cocos nuci-*

fera); the flowers are monœcious; the pericarp of the fruit is divided into an external fibrous epicarp or husk, and internal woody endocarp or shell; within the shell, and closely adherent to it, is the single large seed, consisting of a thick hollow endosperm covered by a thin brown testa; a minute embryo is embedded in a cavity on one side of the endosperm, just beneath a circular depressed patch on the endocarp which is the weakest spot of the endocarp for the exit of the radicle during germination, the cavity of the endosperm is filled with a clear, watery liquid called cocoa-nut milk; **tal** or Palmyra-palm or fan-palm (*Borassus flabellifer*); the flowers are diœcious; the fruit usually 3-celled, 3-seeded, the pericarp consists of a thick, fibrous epicarp filled when ripe with a sweet edible pulp and a thick woody endocarp which forms 3 separate segments or pyrenes; the structure of the seed is very much like that of the Cocoa-nut, but the cavity within the hollow endosperm is comparatively small; **khejur** or Date-palm (*Phœnix sylvestris*), flowers diœcious; the fruit consists of a thin, crustaceous epicarp, a fleshy mesocarp, and a thin, membranous endocarp enclosing a single, hard, horny seed; the trees are tapped for sugar; **supari** or Betel-nut palm (*Areca Catechu*), flowers monœcious, fruits drupe, the seeds or rather stones with ruminated solid endosperm, largely used as a masticatory along with Betel-leaf; **hintal** (*Phœnix paludosa*), a gregarious palm of the Sunderban; flowers diœcious, the stems are used as rafters for huts and leaves used for thatching them; **bet** or Cane or Rattan (*Calamus*), a climbing or trailing palm, flowers polygamo-diœcious, stems largely used for thatching, matting, &c., and also as sticks; **golpata** (*Nipa fruticans*), the leaves are used for thatching

and for making umbrella-covering. The pith-like tissue of the inside of the trunk of Sago-palm (*Sagus*) of the Archipelago yields an abundant starchy matter from which the Sago of commerce is manufactured. *Caryota urens* or **gol-sago** is an ornamental tree of our gardens, it grows wild in Assam, where it forms a favourite food of elephants, it is popularly but wrongly called the Sago-palm.

The Order is mostly anemophilous.

Nat. Order 2. *Araceæ.*—Herbs with watery acrid juice. Stem usually a tuber or corm or rhizome, occasionally climbing by the help of aerial roots. Leaves in climbing species alternate, in others radical. Flowers 1- or 2-sexual on a spadix more or less completely enclosed in a green or coloured spathe. Spadix usually monœcious and androgynous. Perianth usually absent. Stamen usually 1, sometimes 4 to 8. Carpels connate in a 1- to 3-celled ovary. Fruit of many small berries or drupes adnate to the axis of the spadix. Seeds embedded in a mucilaginous pulp with copious albumen.

The distribution is both tropical and temperate. Common plants: **kachu** (*Colocasia antiquorum*) (fig. 71), a common herb largely cultivated for its tuberous rhizome; the lower portion of the spadix is occupied by naked female flowers (*a*) each consisting of a 1-celled ovary only; above the female flowers are some abortive female flowers, then a number of closely-packed naked male flowers (*b*) follow, each consisting of a single 2-celled anther only; the axis of the spadix is prolonged into an elongated APPENDIX (*c*); observe that the flowers are PROTOGYNOUS; **man-kachu** (*Alocasia indica*) with its sub-erect thick rhizome, for which the plant is largely cultivated; **gaja-pipul** (*Scindapsus officinalis*) (fig. 267), a stout

climber often seen in gardens about Calcutta climbing upon palm and other trees; **barha-** (large) **pana** or **toka-pana** (*Pistia Stratiotes*) (see fig. 3), a floating stemless stoloniferous herb with rosettes of sessile obcordate cuneate leaves and numerous fibrous roots

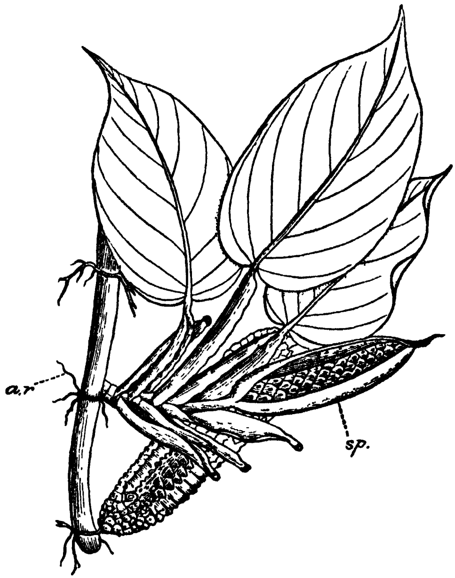


Fig. 267.—Gaja-pipul (*Scindapsus officinalis*)

sp., Spadix. *a.r.*, Adventitious roots.

and a small spadix adnate to the back of the tube of the spathe, free above; **ghet-kachu** or **ghekul** (*Typhonium trilobatum*) (see fig. 105), a common tuberous herb of waste places with a bright-red appendix and a spathe bright-red on the inner surface. Closely allied to *Pistia* is *Lemna* (see fig. 13), Duck-weed, or **khudi-pana**, two or three species of which are found in great abundance in tanks and pools forming a compact green

mass over the surface; each plant consists of a thalloid leaf-like shoot with a capillary tap-root and a small spathe of 1 to 3 very small monœcious flowers (fig. 268) on the side of the thallus or below it; the tap-roots show the root-cap beautifully; **sár-káchu** or **sola-káchu** (*Colocasia nymphæifolia*, Kunth), cultivated to a small extent; **ôl** (*Amorphophallus campanulatus*), largely cultivated for its roundish warty thick corms (see fig. 19).

Fig. 268.—Khudi-pana (*Lemna trisulca*)

Both **ôl** and **ghet-kachu** are odourless during the day but emit a fœtid odour (nauseous flowers) during night and are pollinated by carrion-flies. Coloured spathe and appendix and fœtid smell are the attractions for insects, and in many species there is a pitfall arrangement for entrapping them.

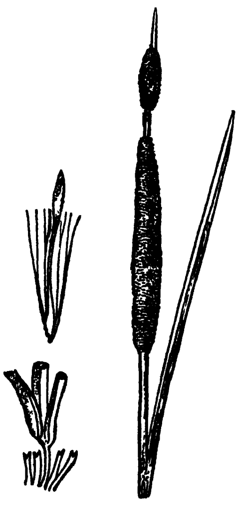


Fig. 269.—Hogla (*Typha angustata*)

Nat. Order 3. *Pandanaceæ*.—This consists of palm-like often branched trees or shrubs with tristichous long leaves spinous at the margin, apex, and often at the keel or back of the mid-rib. **Kia** and **keorha**, different species of *Pandanus* or Screw Pines, are well-known plants with diœcious spadices of whitish odorous flowers of a pale-white colour enclosed in leafy pale-green or white spathes. They abound in village thickets and hedges and in the Sunderban swamps. The spadices are in great request for scenting catechu to be chewed with **pan** (Betel-leaf) and also for the manufacture of scented

water known as **keorha.** The stilted roots of some species are worthy of notice, so also the aggregate spurious pine-apple-like fruit of others.

Mostly moth-flowers.

Nat. Order 4. *Typhaceæ.* — These are aquatic marshy herbs, of which **hogla** (*Typha elephantina* and *T. angustata*) (fig. 269), tall bulrushes 6 to 12 feet high, found abundantly in standing fresh water or slow-moving waters which do not dry up during the hot season, are well known. The leaves of **hogla** are largely used about Calcutta for thatching temporary sheds.

Monœcious, mostly protogynous wind-flowers in capitate or cylindric spikes characterize the Order.

Sub-class 3. GLUMIFERÆ

Nat. Order 1. *Graminaceæ.*—Herbs, rarely shrubs or trees. Stems (culm) generally fistular, i.e. hollow in the internode and solid at the node, frequently strengthened by the deposition of silica (sand) on the outer wall of the epidermal cells. Leaves distichous, sheath forming a tube enclosing the stem but split down the side opposite the blade, with a transverse hyaline or hairy ligule at the apex of the sheath facing the blade. Petiole usually absent, when present very short. Flowers usually 2-sexual, occasionally unisexual and monœcious (Maize), arranged in short spikelets which are usually numerous and either inserted sessilely on the rachis forming a compound spike, or pediceled, forming a raceme or

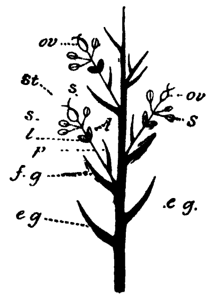


Fig. 270.—Grass Spikelet (diagrammatic)

ov, Ovary. *st*, Stigma. *e.g.*, A pair of empty glumes. *f.g.*, Flowering glume. *p*, Palea. *l*, Lodicules. *s*, Stamens. (After Strasburger.)

panicle. The spikelets (fig. 270) are usually enclosed at the base by two empty bracts named GLUMES (outer or empty glumes) (*e.g.*), one placed a little above the other; these glumes are succeeded by one or more glumes (flowering glumes) (*f.g.*), arranged distichously on the short rachis, and each of these embraces a single flower (although one or more of them are occasionally empty). Within and facing each flowering glume is a small 2-nerved glume known as a PALEA (*p*). Within the palea and the flowering glume are two minute scales called LODICULES (*l*), which are regarded as rudimentary perianth-leaves. Stamens (*s*) are usually 3, but in Rice and Bamboo the number is 6; the anthers are versatile and pendulous. Ovary superior (*ov*), syncarpous, 1-celled with a single erect anatropous ovule; stigma (*st*) usually 2, feathery. Fruit an achene (caryopsis) with the seed closely adherent to the thin pericarp, the latter again more or less adherent to the palea and sometimes also to the flowering glume; the outer glumes also in 1-flowered spikelets as of Rice (figs. 271, 272) may be more or

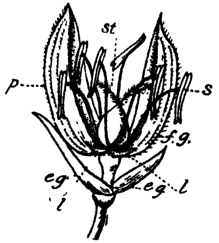


Fig. 271.—One-flowered Spikelet of Dhan or Rice

e.g., Pair of empty glumes. *p*, Palea. *f.g.*, Flowering glume. *s*, Stamens. *l*, Lodicules. *st*, Stigma.

Fig. 272.—Panicle of dhan (*Oryza sativa*)

less adherent to the palea and flowering glume. Seeds possess a minute slanting embryo at the base of the mealy or farinaceous endosperm, to which the SCUTELLUM (cotyledon) is closely applied (fig. 9). The small notch found near one end of cleaned rice is caused by the falling off of the embryo during the husking of the paddy.

This is one of the largest and most important families of plants, universally distributed. Of the large-grained Cereals or Grain-grasses, Rice and Maize are extensively grown in the tropics generally, and India especially, while Wheat, Barley, Oats, and Rye are the chief food-crops of the northern countries. The small-grained cereals known as Millets are largely grown in India, and form the staple food-grain of the poorer classes.

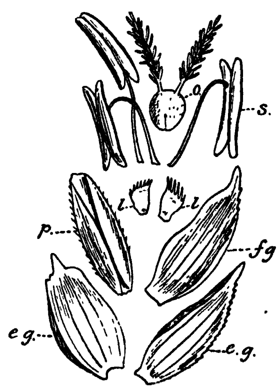


Fig. 273.—Wheat Spikelet dissected (after Dr. Oliver)

e.g., *e.g.*, Two empty glumes. *f.g.*, Flowering glume. *p*, Palea. *l*, Lodicules. *s*, Stamens. *o*, Ovary.

The common plants that are under cultivation or otherwise useful are **dhan** or Paddy or Rice (*Oryza sativa*); **gahm** or Wheat (*Triticum vulgare* (fig. 273), **jab** or Barley (*Hordeum vulgare*), **jai** or Oat (*Avena sativa*), **bhutta** or **janar** or **makai** or Maize or Indian Corn (*Zea Mays*)—all large-grained cereals; **juar** or **dedhan** (*Andropogon Sorghum*), **bajra** (*Pennisetum typhoideum*), **shama-dhan** (*Panicum Crus-galli*, var. *frumentaceum*), **cheena** or **bhura** (*Panicum miliaceum*), **gondli** (*Panicum miliare*), **kodo** (*Paspalum scrobiculatum*), **marhua** (*Eleusine Coracana*)—all small-grained cereals commonly known as

Millets; **akh** (*Saccharum officinarum*), cultivated for sugar; **sabai** (*Ischæmum angustifolium*), a grass from which paper is manufactured in Bengal; **bena** or **khus-khus** (*Andropogon squarrosus*), the fragrant roots of which are woven into screens used for reducing the temperature in summer; **chor-kanta** or **bhant** (*Andropogon aciculatus*), the pest of pastures during the rains; **garh-garh** or Job's Tears (*Coix Lachryma-Jobi*); **kush** (*Eragrostis cynosuroides*), the leaves of which are used in religious ceremonies; **durba** (*Cynodon dactylon*) (fig. 274), a favourite pasture-grass; **bans** or Bamboo (*Bambusa arundinacea*), used largely for building and thatching purposes; various species of Reeds, such as **durma**-reed (*Phragmites Karka*), the split stems of which yield the common **durma**-mats of Calcutta; **kharhî**-reeds (*Saccharum fuscum*), used in making the writing pens of village schools, and also for screens and light fencing; **keshe** (*Saccharum spontaneum*), used in inferior thatching as a substitute for straw- and **ulu**-thatching; it is a binding grass of sand-wastes; **ulu** (*Imperata arundinacea*), a grass largely used as a kind of thatching superior to straw-thatching.

Fig. 274.—Durba (*Cynodon dactylon*)

This family, as already stated, is distinctly anemophilous. The flowers are usually ephemeral, opening only once; the opening or divergence of the flowering glume and palea is effected by the two lodicules, which at the time of the opening of flowers become swollen and rigid, and thereby separate the palea

from the flowering glume, and cause the stamens and the feathery stigmas elastically to spring out and expose themselves to the air. Shortly the flowers fade, the lodicules shrivel up, and the flowering glume with the palea regain their former position. *Oryza sativa* is protogynous, and Maize distinctly protandrous. In the male spikes of the Maize the presence of female flowers, and therefore of single ovaries, is not uncommon.

Nat. Order 2. *Cyperaceæ.*—Herbs with grass-like aspect. Distinguished from *Graminaceæ* or true Grasses by (1) usually solid triangular stem, (2) tristichous leaves, (3) absence of ligule, and (4) closed tubular sheath.

Fig. 275.—*Scirpus triqueter*, var. *segregata*. Club-Rush of Sundarban

This is a large family of plants universally distributed, especially in moist situations and on the margins of streams. Common plants: **mootha** (*Cyperus rotundus*); **madur-kati** (*Cyperus tegetum*), the split stems of which are used in the manufacture of ordinary mats; and **keshur** (*Scirpus grossus*, var. *Kysoor*); *Scirpus triqueter*, var. *segregata* (fig. 275) is the Club-Rush of the Sundarban. The Papyrus or paper of the Egyptians was obtained from the compressed pith of the Egyptian Papyrus (*Papyrus antiquorum* or *Cyperus Papyrus*), a native of the Upper Nile and other African rivers.

It is a distinctly anemophilous family, cross-pollination being favoured by protogyny, more rarely by protandry or diœcism. The Cyperaceæ are commonly known by the name of Sedges.

Division 2. GYMNOSPERMIA

The *Gymnospermia* form a smaller group of plants than the parallel group of *Angiospermia*, hence it is not necessary to split up this Division of plants into intermediate Classes and Sub-classes, as is necessary in *Angiospermia*.

Characters of the structure of *Gymnospermia* as compared with Dicotyledons.—Flowers achlamydeous—unisexual, monœcious or diœcious, anemophilous. Carpels open, pollen falls directly on to the ovule. Structure of stems and roots similar to that of Dicotyledons, but the vessels are replaced by tracheids, the bordered pits very prominent, and there are resin ducts both in the cortex and the wood. It is at once divided into three Natural Orders, namely, the *Cycadaceæ*, the *Coniferæ*, and the *Gnetaceæ*.

Nat. Order 1. *Cycadaceæ*.—Stem usually unbranched and thick, like the stems of Palms. The primary root is a tap-root, as in Dicotyledons. Leaves are closely crowded upon the stem, and of two kinds, namely, large, stiff, sometimes spiny, pinnate or pinnifid, green foliage leaves, and small, dry, brown scale-leaves, with a felt-like mass of brown hairs. In the genus *Cycas* (fig. 276) the pinnate leaves form a handsome palm-like crown at the top of the stem. The two kinds of leaves alternate with each other in successive zones of the stem. In *Cycas*, the pinnæ or leaflets when young are circinately folded, as in Ferns, but the leaf as a whole grows straight forward. In the genus *Zamia* the leaf itself is circinately folded, while the pinnæ or leaflets are straight. The crown of foliage leaves is renewed at intervals of one or two years, but the scales and the bases of the leaf-stalk persist on the stem. The flowers are always

diœcious, achlamydeous, and at the summit of the stem. In *Zamia* the male and female flowers form

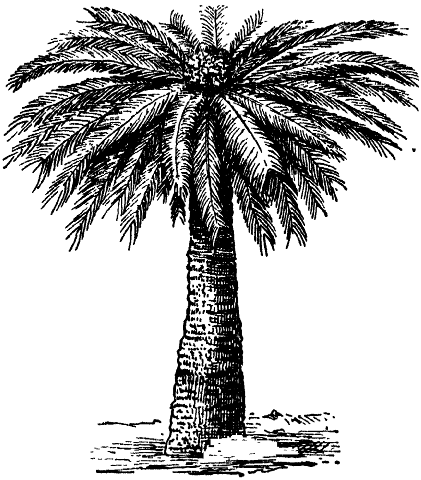


Fig. 276. –*Cycas revoluta* (after Strasburger)

long cone-like spikes. In male flowers the stamens are crowded peltate scales, often stalked, bearing pollen-sacs (microsporangia) in clusters on their under surface. In *Cycas* the female flowers occupy the apex of the stem, and form a much less distinctly cone-like structure than in *Zamia*. The carpels in *Cycas* (fig. 277) are small, pinnate or pinnifid leaves, the lower pinnæ or leaflets of which are replaced by ovules (macrosporangia).

Fig. 277.—Carpellary Leaf of *Cycas revoluta* (after Strasburger)

o, Ovule.

The *Cycas* are a very old group of plants, especially characteristic of the Mesozoic Periods, having attained their maximum development

in Jurassic times. At the present day they are confined to tropical and warm temperate climates. The genus *Cycas* is almost universally distributed within these limits.

In Bengal, *Cycas revoluta* (see fig. 276), a Japanese import, is commonly grown in gardens, and resembles a Date tree in appearance; *C. pectinata* is an evergreen palm-like tree of Assam and Chittagong.

Nat. Order 2. *Coniferæ.*—The *Coniferæ* comprises the Pines, Firs, Larches, Yews, Cedars, Cypresses, Junipers, Deodar, and other more or less common plants of the temperate climates and cold countries. Only a few are grown in the plains of Bengal, as ornamental garden plants. The family is characterized by abundant branching of the stem, relatively small entire leaves, often needle-shaped or filiform, and distinctly cone-like fruit. The common Himalayan Pine is the **cheer** (*Pinus longifolius*), and the common Khasia Pine or **saral-gacch** is *Pinus Khasya* (fig. 278). *Thuja orientalis* Linn., a small tree grown in our gardens, commonly goes by the Bengali name of **belati-jhau.** *Podocarpus nerifolia* is a tall, glabrous tree, 30 to 50 feet high, found in Chittagong.

The flowers are commonly diœcious, rarely monœcious. The male flowers are arranged in short spikes or catkins, consisting of a short axis or rachis on which are inserted minute imbricating scales, each scale bearing on its under surface 2 pouch-like pollen-sacs (microsporangia) (fig. 279); each of these scales, in fact, is a stamen. The female flowers (see fig. 278) also form a conical spike consisting of an axis on which are inserted the imbricated scales, known as BRACT-SCALES (*a*). In the axil of each of the bract-scales is another scale known as OVULIFEROUS SCALE (*cl*), which bears on the basal portion of the upper

surface of it 2 ovules (*o*) (macrosporangia). Each of the latter scales is looked upon as an open carpellary

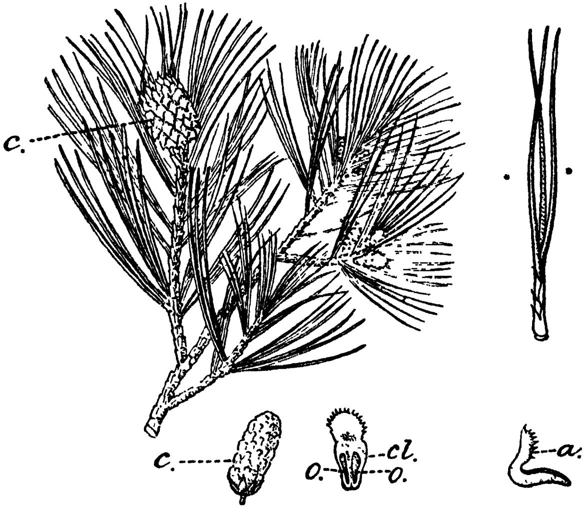


Fig. 278.– Saral-gacch or Khasia Pine (*Pinus Khasya*)

a, Bract scale. *c*, Cone. *cl*, Ovuliferous scale or carpellary leaf. *o*, Ovule.

leaf or carpel (a female flower) arising in the axil of the bract-scale. From this point of view each female spike or cone is an inflorescence with many female flowers or carpellary leaves, each situated in the axil of a bract.

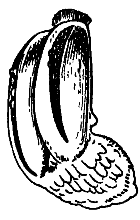


Fig. 279.– Staminal Scale of Pine

From another point of view the whole female spike or cone is looked upon as a single achlamydeous female flower with many carpels, the ovuliferous scales being looked upon as placental outgrowths from the bract-scales, and the bract-scales, according to this view, are the carpels or carpellary leaves, and not bracts.

Nat. Order 3. *Gnetaceæ.*—This differs very much in habit from the Pines (*Coniferæ*). *Gnetum* and *Ephedra* are two important genera. The *Gnetum* are climbing shrubs or erect trees with jointed stems, opposite shining entire leaves, and axillary or terminal spikes of verticillate monœcious or diœcious flowers. The *Ephedra* are leafless, much-branched shrubs growing in desert regions of the Temperate Zones. Associated with them is *Welwitschia mirabilis*, a most extraordinary and anomalous dwarf tree of South Africa, which attains a great age. It has a table-like trunk 4 to 5 feet in diameter, seldom raised more than 6 to 12 inches above the ground, bearing a single pair of leaves about 6 feet long, persisting throughout the life of the plant, and believed to be the first pair of leaves or cotyledons. When old, these leaves split into numerous strips, which lie stretched upon the ground.

Coniferæ, *Cycadaceæ*, and *Gnetaceæ* are anemophilous. The male flowers form a large quantity of very light, dry, mealy pollen, sometimes especially adapted for wind-transport by appendages resembling little bladders filled with air. The pollen is so abundant that in Pine-woods the pollen is often carried some distance by the wind, and when washed to the ground by rain produces the phenomena known as "Sulphur showers". In all the families the micropyle of the naked ovule secretes a drop of liquid during pollination, which catches the pollen grains brought by the wind and draws them into the micropyle as it dries up.

APPENDIX A

TABULAR VIEW OF ENGLER AND PRANTL'S SYSTEM OF CLASSIFICATION, WITH A FEW DEVIATIONS

Division. **SPERMATOPHYTA**

Subdivision I. **Gymnospermæ**

Ord.* Coniferales.
  Fam.* *Taxaceæ*.
  ,, Pinaceæ or Coniferæ.
  ,, Gnetaceæ.

Ord. Cycadales.
  Fam. Cycadaceæ.

Subdivision II. **Angiospermæ**

Class I. MONOCOTYLEDONEÆ

Ord. Pandanales.
  Fam. Typhaceæ.
  ,, *Sparganiaceæ*
  ,, Pandanaceæ.
  ,, Palmaceæ.

Ord. Naiadales.
  Fam. Naiadaceæ.
  ,, *Juncaginaceæ*.
  ,, Alismaceæ.
  ,, Hydrocharidaceæ.

Ord. Graminales.
  Fam. Gramineæ.
  ,, Cyperaceæ.

Ord. Arales.
  Fam. {Araceæ. *Lemnaceæ*.}

Ord. Xyridales.
  Fam. *Eriocaulaceæ*.
  ,, *Xyridaceæ*.
  ,, *Mayacaceæ*.
  ,, Commelinaceæ.
  ,, *Bromeliaceæ*.
  ,, Pontederiaceæ.

Ord. Liliales.
  Fam. Juncaceæ.
  ,, {Liliaceæ. *Hæmodoraceæ*.}
  ,, Dioscoreaceæ.
  ,, Amaryllidaceæ.
  ,, Iridaceæ.

Ord. Scitaminales.
  Fam. {Marantaceæ. Zingiberaceæ. Musaceæ.} Scitaminaceæ.

Ord. Orchidales.
  Fam. *Burmanniaceæ*.
  ,, Orchidaceæ.

* ORDERS in this system correspond to COHORTS, and FAMILIES to ORDERS, in Hooker's system. Families in italics in the above Table have not been treated of in this book. Families within brackets { } have been treated together.

Class II. DICOTYLEDONEÆ

Sub-class I. Archichlamydeæ

Ord. Piperales.
Fam. Piperaceæ.

Ord. Salicales.
Fam. Salicaceæ.

Ord. Myricales.
Fam. *Myricaceæ.*
,, Casuarinaceæ.

Ord Leitneriales.
Fam. *Leitneriaceæ.*

Ord. Juglandales.
Fam. Juglandiaceæ.

Ord. Fagales.
Fam. { *Betulaceæ.* / *Fagaceæ.* } Cupuliferæ.

Ord. Urticales.
Fam. Urticaceæ.

Ord. Santalales.
Fam. Santalaceæ.
,, Loranthaceæ.
,, Balanophoraceæ.

Ord. Aristolochiales.
Fam. Aristolochiaceæ.

Ord. Polygonales.
Fam. Polygonaceæ.

Ord. Chenopodiales.
Fam. Chenopodiaceæ.
,, Amarantaceæ.
,, *Phytolaccaceæ.*
,, Nyctaginaceæ.
,, *Illecebraceæ.*
,, *Aizoaceæ.*

Ord. Caryophyllales.
Fam. Caryophyllaceæ.
,, Portulacaceæ.
,, Tamaricaceæ.

Ord. Ranunculales.
Fam. *Ceratophyllaceæ.*
,, Nymphæaceæ.
,, Ranunculaceæ.
,, Nelumbiaceæ.
,, Dilleniaceæ.
,, Magnoliaceæ.
,, *Calycanthaceæ.*
,, Anonaceæ.
,, Menispermaceæ.
,, Berberidaceæ.
,, Lauraceæ.
,, Myristicaceæ.

Ord. Papaverales.
Fam. Papaveraceæ.
,, Fumariaceæ.
,, Cruciferæ.
,, Capparidaceæ.
,, Resedaceæ.
,, Bixaceæ.

Ord. Sarraceniales.
Fam. *Sarraceniaceæ.*
,, Droseraceæ.

Ord. Rosales.
Fam. *Podostemaceæ.*
,, Crassulaceæ.
,, *Saxifragaceæ.*
,, *Hamamelidaceæ*
,, *Platanaceæ.*
,, Rosaceæ.
,, Leguminosæ.

Ord. Geraniales.
Fam. Linaceæ.
,, { *Oxalidaceæ.* / Geraniaceæ. }
,, *Zygophyllaceæ.*
,, Rutaceæ.
,, *Simarubaceæ.*
,, Polygalaceæ.
,, Euphorbiaceæ.

Fam. *Callitrichaceæ*.
,, Malpighiaceæ.
,, Meliaceæ.

Ord. Sapindales.
Fam. *Buxaceæ*.
,, *Empetraceæ*.
,, *Limnanthaceæ*. (See Gentianaceæ.)
,, Anacardiaceæ.
,, *Cyrillaceæ*.
,, *Aquifoliaceæ*.
,, *Celastraceæ*.
,, *Staphyleaceæ*.
,, { *Aceraceæ*. / Sapindaceæ. }
,, *Balsaminaceæ*. (See Geraniaceæ.)

Ord. Rhamnales.
Fam. Rhamnaceæ.
,, Vitaceæ or Ampelidaceæ.

Ord. Malvales.
Fam. Tiliaceæ.
,, Malvaceæ.
,, Sterculiaceæ.

Ord. Violales.
Fam. Ternstrœmiaceæ.
,, Hypericaceæ.
,, *Elatinaceæ*.
,, *Cistaceæ*.
,, Violaceæ.
,, Passifloraceæ.
,, Cucurbitaceæ.
,, *Loasaceæ*.
,, Guttiferæ.
,, Dipterocarpaceæ.
,, Begoniaceæ.

Ord. Opuntiales.
Fam. Cactaceæ.

Ord. Myrtales.
Fam. *Thymelaceæ*.
,, *Elæagnaceæ*.
,, Lythraceæ.
,, Melastomaceæ.
,, Onagraceæ.
,, Haloragaceæ.
,, Myrtaceæ.
,, Combretaceæ.
,, Rhizophoraceæ.

Ord. Umbellales.
Fam. Araliaceæ.
,, Umbelliferæ.
,, Cornaceæ.

Sub-class II. Metachlamydeæ

Ord. Ericales.
Fam. Ericaceæ.
,, *Diapensiaceæ*.

Ord. Primulales.
Fam. Plumbaginaceæ.
,, *Primulaceæ*.
,, Myrsinaceæ.

Ord. Ebenales.
Fam. Sapotaceæ.
,, Ebenaceæ.
,, Styracaceæ.

Ord. Gentianales.
Fam. Oleaceæ.
,, Loganiaceæ.
,, Gentianaceæ.
,, Apocynaceæ.
,, Asclepiadaceæ.

Ord. Polemoniales.
Fam. Convolvulaceæ.
,, *Polemoniaceæ*.
,, *Hydrophyllaceæ*.
,, Boraginaceæ.

Fam. Verbenaceæ.
,, Labiatæ.
,, Solanaceæ.
,, Scrophulariaceæ
,, *Lentibulariaceæ* or Utriculariaceæ.
,, Orobanchaceæ.
,, Bignoniaceæ.
,, *Martyniaceæ.*
,, Acanthaceæ.
,, *Phrymaceæ.*
,, Gesneraceæ.
,, Pedaliaceæ.

Ord. Plantaginales.
Fam. *Plantaginaceæ.*

Ord. Rubiales.
Fam. Rubiaceæ.
,, Caprifoliaceæ.
,, Valerianaceæ.
,, *Dipsacaceæ.*

Ord. Campanulales.
Fam. Cucurbitaceæ.
,, {Campanulaceæ. / *Lobeliaceæ.*}
,, Compositæ.

APPENDIX B

ANALYTICAL KEY TO THE ORDERS, CARRIED OUT IN SOME CASES TO GENERA

(After Gray)

NOTE.—*Orders and Genera in italics are not treated of in the book.*

Division II. **SPERMATOPHYTA** (Phanerogamia)	Page.	No. of Order.
Plants with true flowers containing stamens, pistils, or both. Reproduction normally by seeds containing an embryo.		
Sub-division I. **Gymnospermia**		
Ovules not in a closed ovary. Trees and shrubs with needle-shaped, linear, or scale-like mostly evergreen leaves, and monœcious or diœcious flowers. **A.**		
A. Flowers not catkin-like . . . . Cycadaceæ.	360	1
A. Flowers themselves catkin-like or borne in catkins, which become cones or berry-like Pinaceæ or Coniferæ.	308	2
Gnetacæ.		
A. Flowers solitary, axillary; seed solitary, more or less enveloped in a pulpy disk *Taxaceæ.*	310	3

	Page.	No. of Order.
Sub-division II. **Angiospermia**		
Ovules borne in a closed ovary, which at maturity becomes the fruit.		
Class I. MONOCOTYLEDONS		
Stems without central pith or annular layers, but having the woody fibres distributed through them (a transverse slice showing the fibres as dots scattered through the cellular tissue). Embryo with a single cotyledon, the early leaves always alternate. Parts of the flower usually in threes or sixes, never in fives. Leaves mostly parallel-veined.		
B. Small lens-shaped, ellipsoidal, or flask-shaped free-swimming aquatics without true leaves . . . . Lemna (Genus).	298	
B. Plants with stems and leaves (sometimes scale-like). **C.**		
C. Perianth free from the ovary or none. D.		
D. Perianth wanting, or scale-like or bristle-form divisions. **E.**		
E. Flowers inclosed or subtended by imbricated husk-like scales (glumes); grass-like plants with jointed stems, sheathing (mostly narrow) leaves, and 1-seeded fruit.		
Stems hollow, round or flattened; leaf-sheaths split; anthers attached by the middle . . . . Gramìnaceæ.	301	1
Stems usually more or less triangular, solid; leaf-sheaths not split; anthers attached at the base . . . . Cyperaceæ.	305	2
E. Flowers not inclosed in husk-like scales (though sometimes in involucrate heads). **F.**		
F. Immersed aquatics, branching and leafy, the upper leaves often floating.		
Flowers perfect . . . . Naiadaceæ.	283	5
Flowers monœcious or diœcious.		
Flowers in globose heads . . . . *Sparganiaceæ.*		
Flowers axillary, solitary . . . . Naiadaceæ.	283	5

		Page.	No. of Order.
F. Terrestrial or marsh plants. **G.**			
G. Leaves petioled, the blade net-veined	Araceæ.	298	2
G. Leaves linear or sword-shaped, parallel-veined, not petioled. **H.**			
H. Flowers monœcious or diœcious.			
Flowers in cylindrical spikes	Typhaceæ.	301	4
Flowers in spadices	Pandanaceæ.	300	3
Flowers in heads.			
Heads spheroidal, pubescent, involucrate . . .	*Eriocaulaceæ.*		
Heads globose, glabrous, not involucrate . . .	*Sparganiaceæ.*		
H. Flowers perfect.			
Flowers in a dense spike, this borne on the margin of a 2-edged scape; root aromatic . . Acorus (Genus)—Ord:	Araceæ.	298	2
Scapes or peduncles cylindrical.			
Ovaries 3-6, separating at least when ripe . . .	Alismaceæ.	282	4
Ovary single, 3-carpeled	Juncaceæ.	281	3
D. Perianth always present, herbaceous or coloured, neither scale-like nor bristle-form. I.			
I. Pistils, 3, 6, or more in a head or ring	Alismaceæ.	282	4
I. Pistil one, compound (cells or placentæ mostly 3). **J.**			
J. Stamens 3.			
Moss-like, aquatic; flowers solitary	*Mayacaceæ.*		
Rush-like marsh or bog plants; flowers in spikes, racemes, or heads.			
Flowers racemose or spicate	Alismaceæ.	282	4
Flowers in dense scaly heads	*Xyridaceæ.*		
J. Stamens 4	*Maianthemum* (Genus).		
J. Stamens 6. **K.**			
K. Stamens all alike and fertile.			
Grey scurfy moss-like epiphyte	*Bromeliaceæ.*		

	Page.	No. of Order.
Not epiphytic:		
Ovary of nearly separate carpels . . . . . . Alismaceæ.	282	4
Ovary (often angled or lobed) not deeply cleft.		
Divisions of the perianth alike or nearly so.		
Perianth woolly . . . . *Hæmodoraceæ.*		
Perianth not woolly.		
Plant rush-like; perianth small, greenish or purplish brown Juncaceæ.	281	3
Plant not rush-like . . . . Liliaceæ.	276	1
Shrubs or Trees; stem usually unbranched, flowers in spadices Palmaceæ.	296	1
Divisions of the perianth unlike, 3 green sepals and 3 coloured petals.		
Stem-leaves ovate or oblong, 3 in a whorl Trillium (Genus)—Ord: Pontederiaceæ.	284	6
Stem-leaves linear or nearly so; flowers umbeled Commelinaceæ.	280	2
K. Stamens dissimilar, or only 3 with fertile anthers.		
Perianth of 3 herbaceous sepals and 3 coloured ephemeral petals Commelinaceæ.	280	2
Perianth tubular, 6-lobed . . . . Pontederiaceæ.	284	6
K. Stamens 1–2; flowers irregular.		
Anthers 2-celled; seeds many . . . . Orchidaceæ.	292	11
Anthers 2-celled or 1-celled; seeds solitary . . . . . . Scitamineæ.	288	10
C. Perianth present, adnate to the ovary. L.		
L. Stamens 3 or more; flowers mostly regular or nearly so. **M.**		
M. Climbing plant with net-veined ovate leaves . . . . . Dioscoreaceæ.	287	9
M. Not climbing; leaves parallel-veined.		
Perianth woolly, only partially adnate to the ovary . . . *Hæmodoraceæ.*		
Perianth not woolly, adnate to the whole surface of the ovary.		
Aquatics; flowers diœcious or polygamous . . . . Hydrocharidaceæ.	294	12
Terrestrial; flowers perfect.		
Stamens 6 . . . . Amaryllidaceæ.	284	7

	Page.	No. of Order.
Stamens 3.		
Leaves 2-ranked, equitant; stamens opposite the outer segments of the perianth . . . . Iridaceæ.	286	8
Leaves not 2-ranked, the cauline scale-like; stamens opposite the inner segments of the perianth . . . . . . *Burmanniaceæ.*		

Class II. Dicotyledons

Stems formed of bark, wood, and pith; the wood forming a zone between the other two, and increasing, when the stem continues from year to year, by the annual addition of a new layer to the outside, next to the bark. Leaves net-veined. Embryo with a pair of opposite cotyledons. Parts of the flower mostly in fours or fives. **N.**

	Page.	No. of Order.
N. Corolla none; calyx present or absent. O.		
O. Flowers monœcious or diœcious, one or both sorts in catkins. **P.**		
P. Only one sort of flowers in catkins or catkin-like heads.		
Fertile flowers in a short catkin or catkin-like head . . . Urticaceæ.	268	6
Fertile flowers single or clustered; the sterile in slender catkins (except in *Fagus*).		
Leaves pinnate; fertile flowers and fruit naked . . . Juglandaceæ.	270	7
Leaves simple; fertile flowers 1–3 in a cup or involucre *Fagaceæ*—Cupuliforæ.	270	8
P. Both sterile and fertile flowers in catkins or catkin-like heads. **Q.**		
Q. Ovary many-ovuled; fruit many-seeded.		
Ovary and pod 2-celled; seeds not tufted *Liquidambar* (Genus)—Ord: *Hamamelidaceæ.*		
Ovary and pod 1-celled; seeds hairy, tufted . . . . Salicaceæ.	272	10
Q. Ovary 1–2-celled; cells 1-ovuled; fruit 1-seeded.		
Parasitic on trees; fruit a berry . . . . . . Loranthaceæ.	273	16
Trees and shrubs, not parasitic.		
Calyx regular, in fertile flower succulent in fruit . . . Urticaceæ.	268	6

	Page.	No. of Order.
Calyx none or rudimentary and scale-like.		
Style and stigma 1, simple.		
Leaves palmately angled or lobed . . . . . *Platanaceæ.*		
Leaves ovate or oblong, entire . . . . . . *Leitneriaceæ.*		
Styles or long stigmas 2.		
Fertile flowers 2 or 3 at each scale of the catkin *Betulaceæ*—Cupuliferæ.	270	8
Fertile flowers single under each scale; nutlets naked, waxy-coated, or drupe-like . . . . *Myricaceæ.*		
O. Flowers not in catkins. **R.**		
R. Ovary or its cells containing only 1–2 (rarely 3–4) ovules. **S.**		
S. Pistils more than 1, distinct or nearly so.		
Stamens inserted on the calyx; leaves with stipules . . . Rosaceæ.	211	2
Stamens inserted on the receptacle.		
Leaves punctate with transparent dots *Zanthoxylum* (Genus)—Ord: Rutaceæ.	199	30
Leaves not dotted.		
Calyx present, usually coloured or petal-like . . Ranunculaceæ.	174	1
Calyx none, flowers spiked . . . . Piperaceæ.	274	17
S. Pistil 1, simple or compound. **T.**		
T. Ovary free from the calyx, which is sometimes wanting. U.		
U. Stipules (ocreæ) sheathing the stem at the nodes.		
Tree; calyx none . . . . *Platanaceæ.*		
Herbs; calyx present, commonly corolla-like . . . Polygonaceæ.	262	4
U. Stipules not sheathing the stem, or none. **V.**		
V. Herbs. **W.**		
W. Aquatic, submerged or nearly so.		
Leaves whorled, dissected; style 1 . . . . *Ceratophyllaceæ.*		
Leaves opposite, entire; styles 2; ovary 4-celled . *Callitrichaceæ.*		

	Page.	No. of Order.
W. Not aquatics. **X.**		
X. Styles 10; ovary and berry 10-celled . . . . *Phytolaccaceæ.*		
X. Style, if any, and stigma 1.		
Flowers unisexual; ovary of the fertile flowers 1-celled Urticaceæ.	268	6
Flowers perfect; pod 2-celled, 2-seeded *Lepidium* (Genus)—Ord: Cruciferæ.	180	8
X. Styles 2 to 3 or branched; ovary 1–4-celled. **Y.**		
Y. Leaves palmately lobed or divided . *Cannabineæ*—Urticaceæ.	268	6
Y. Leaves not palmately lobed or divided. **Z.**		
Z. Ovary and pod 3-celled; juice usually milky.		
Flowers in basal spikes; stamens 4; filaments thick, flattened *Buxaceæ.*		
Inflorescence various, not of basal spikes; stamens 1–∞, rarely 4; filaments not conspicuously thick Euphorbiaceæ.		
Z. Ovary not 3-celled; juice not milky. ***a.***		
a. Flowers in numerous small involucrate heads; fruit a 3-angled achene *Eriogonum* (Genus)—Ord: Polygonaceæ.	262	4
a. Flowers not involucrate.		
Leaves covered at least beneath with stellate hairs; embryo straight . . . . . . Euphorbiaceæ.	263	5
Leaves without stellate hairs; embryo curved or coiled.		
Stipules scarious . . . . . . *Illecebraceæ.*		
Stipules none.		
Leaves opposite.		
Plant fleshy Salicornia (Genus)—Ord: Chenopodiaceæ.	261	3
Not fleshy.		
Flowers in heads or spikes, these often panicled; anthers 1-celled . . . . Amaranthaceæ.	259	2
Flowers sessile in forks of branching inflorescence *Illecebraceæ.*		

	Page.	No. of Order.
Leaves alternate.		
Flowers and bracts scarious . Amaranthaceæ.	259	2
Flowers small, chiefly greenish; no scarious bracts Chenopodiaceæ.	261	3
V. **Shrubs or trees.**		
Leaves small, linear, or scale-like; low heath-like shrubs *Empetraceæ.*		
Leaves oblong or orbicular; never heath-like.		
Leaves opposite.		
Fruit 3-celled, not winged . . . . . . Rhamnaceæ.	201	32
Fruit 2-celled, a double samara . . *Aceraceæ*—Sapindaceæ.	202	34
Fruit 1-celled, a single samara . . . . . Oleaceæ.	239	13
Leaves alternate.		
Ovary 3-celled . . . . Rhamnaceæ.	201	32
Ovary 1–2-celled.		
Styles and stigmas 2 . . . . Urticaceæ.	268	6
Style and stigma 1.		
Anthers opening lengthwise . . . . *Thymeleaceæ.*		
Anthers opening by uplifted lids . . . Lauraceæ.	272	14
Style 0; stigma 1 . . . . Myristicaceæ.	272	12
T. **Ovary inferior, or so closely and permanently invested by the calyx as to appear so.**		
Parasites on the branches of trees . . . . . Loranthaceæ.	273	16
Parasites on roots . . . . Balanophoraceæ.	272	12
Aquatic herbs . . . . Haloragaceæ.	214	5
Terrestrial.		
Herbs with calyx coloured like a corolla.		
Leaves opposite, simple . . . . . . Nyctaginaceæ.	258	1
Leaves alternate, pinnate . *Sanguisorba* (Genus)—Ord: Rosaceæ.		
Leaves alternate, simple . . . . Santalaceæ.	272	11

	Page.	No. of Order.
Shrubs or trees.		
Leaves scurfy . . . . *Elæagnaceæ.*		
Leaves not scurfy, opposite *Nestronia* (Genus)—Ord: Santalaceæ.	272	11
Leaves not scurfy, alternate.		
Style 1, stigmatic down one side; flowers solitary, in pairs, or in umbel-like clusters . . *Nyssa* (Genus)—Ord: Cornaceæ.	229	18
Style 1, short; stigma terminal; flowers racemose or cymose Santalaceæ.	272	11
Styles 2 . . . . *Hamamelidaceæ.*		
R. Ovary or its cells containing many ovules. ***b.***		
b. Calyx none; ovary and fruit naked.		
Aquatic herb . . . . *Podostemaceæ.*		
Tree or shrub . . . . *Hamamelidaceæ.*		
b. Calyx present. ***c.***		
c. Ovary superior.		
Ovaries 2 or more, separate . . . . . . Ranunculaceæ.	174	1
Ovary single.		
Ovary 5-celled, 5-beaked; leaves scattered *Penthorum* (Genus)—Ord: Crassulaceæ.	212	3
Ovary 3–5-celled; leaves opposite or whorled . *Aizoaceæ* or *Ficoidaceæ.*		
Ovary 1–2-celled.		
Leaves compound . . . . Ranunculaceæ.	174	1
Leaves simple.		
Calyx of separate sepals . . . . . . Caryophyllaceæ.	187	17
Calyx 5-toothed or cleft . . *Glaux* (Genus)—Ord: *Primulaceæ.*		
Calyx 4-toothed . . . . Lythraceæ.	219	9
c. Ovary and pod inferior.		
Ovary 6-celled; stamens 6–12 . . . . . . Aristolochiaceæ.	273	15
Ovary 4-celled; stamens 4 . . Ludwigia (Genus)—Ord: Onagraceæ.	220	10
Ovary 1-celled; stamens 8–10 *Chrysosplenium* (Genus)—Ord: *Saxifragaceæ.*		

	Page.	No. of Order.
N. Both calyx and corolla present. *d.*		
d. **Corolla of separate petals.** *e.*		
e. Stamens numerous, at least more than 10 (rarely 9–10 in *Polanisia*), and more than twice as many as the sepals or calyx-lobes. *f.*		
f. **Calyx entirely free and separate from the pistil or pistils.** *g.*		
g. Pistils several or many, wholly distinct or united at base into a strongly-lobed or several-beaked ovary. *h.*		
h. Aquatics with peltate leaves . . . . Nymphæaceæ Nelumbiaceæ.	183	12, 13
h. Terrestrial plants; climbers.		
Climbers.		
Leaves alternate . . . . Menispermaceæ.	178	5
Leaves opposite . . Clematis (Genus)—Ord: Ranunculaceæ.	174	1
Not climbing.		
Filaments united into a tube . . . . . . Malvaceæ.	192	24
Filaments not united.		
Leaves opposite, entire . . . . . . *Calycanthaceæ.*		
Leaves alternate.		
Stamens on the calyx . . . . Rosaceæ.	211	2
Stamens on the receptacle or disk.		
Trees or shrubs.		
Sepals and petals imbricated . . . . . Magnoliaceæ.	178	4
Sepals and petals valvate . . . . . Anonaceæ.	177	3
Sepals imbricated, persistent, often accrescent Dilleniaceæ.	176	2
Herbs . . . . Resedaceæ.	182	11
g. Pistils strictly one as to ovary; the styles or stigmas may be several. *i.*		
i. Leaves punctate with translucent dots . . . . . Hypericaceæ.	188	20
i. Leaves not punctate. *j.*		
j. Ovary simple, 1-celled.		
Ovules 2 . . . . Rosaceæ.	211	2

	Page.	No. of Order.
Ovules many.		
Leaves 2–3-ternately compound or dissected . Ranunculaceæ.	174	1
Leaves peltate, lobed *Podophyllum* (Genus)—Ord: Berberidaceæ.	179	6
j. Ovary compound.		
Ovary 1-celled.		
Sepals 2 (rarely 3 as in Argemone), caducous; juice milky or coloured; placentæ parietal . . . . Papaveraceæ.	179	7
Sepals 2; juice watery; placentæ central . . . Portulacaceæ.	187	18
Sepals 4; juice watery; placentæ parietal . . . Capparidaceæ.	181	9
Sepals 3 or 5, persistent; juice watery; placentæ parietal *Cistaceæ.*		
Sepals 4–5, not persistent, placenta parietal . . Bixaceæ.	184	15
Ovary several-celled.		
Calyx valvate in bud.		
Herbs, shrubs, or trees; stamens united; anthers 1-celled Malvaceæ.	192	24
Trees; anthers 2-celled . . . . Tiliaceæ.	195	26
Trees or shrubs; anthers 2-celled, often with intervening staminodia Sterculiacæ.	194	25
Calyx imbricated in bud.		
Shrubs; stamens on the base of the petals . . Ternstrœmiaceæ.	190	22
Shrubs or trees; stamens not on the base of the petals Guttiferæ.	189	21
Aquatic or marsh-dwelling herbs.		
Leaves tubular or trumpet-shaped; placentæ in the axis *Sarraceniaceæ.*		
Leaves (when matured) flattish, never tubular or trumpet-shaped; ovules in the partitions of the ovary . . . Nymphæaceæ.	183	12
f. **Calyx more or less adherent to a compound ovary.**		
Ovary 7–30-celled.		
Cells many-ovuled; aquatic herb . . . . . . Nymphæaceæ.	183	12

	Page.	No. of Order.
Cells 10, each 1-ovuled; trees or shrubs *Amelanchier* (Genus)—Ord: Rosaceæ.	211	2
Ovary 6-celled . . . . *Asarum.*		
Ovary 1–5-celled.		
Fleshy-stemmed, without true foliage; petals many . . . Cactaceæ.	225	15
Leaves present.		
Sepals or calyx-lobes 2; ovules arising from the base of a 1-celled ovary Portulacaceæ.	187	18
Sepals or calyx-lobes more than 2.		
Leaves opposite; stipules none . . . . . . *Saxifragaceæ.*		
Leaves alternate.		
Stipules present . . . . Rosaceæ.	211	2
Stipules none.		
Herbs with rough-pubescent leaves . . . . . *Loasaceæ.*		
Trees or shrubs . . . . Styracaceæ.	239	10
e. Stamens not more than twice as many as the petals. ***k.***		
k. Stamens of the same number as the petals and opposite them.		
Ovaries 3–6, separate; woody vines . . . . . . Menispermaceæ.	178	5
Ovary only one.		
Ovary 2–4-celled.		
Calyx-lobes minute or obsolete; petals valvate . Vitaceæ or Ampelidæ.	201	33
Calyx 4–5-cleft; petals involute . . . . Rhamnaceæ.	201	32
Ovary 1-celled.		
Anthers opening by uplifted lids . . . . Berberidaceæ.	179	6
Anthers not opening by uplifted lids.		
Style 1, unbranched; stigma 1 . . . . *Primulaceæ.*		
Styles, style-branches, or stigmas more than 1.		
Sepals or calyx-lobes 2 . . . . Portulacaceæ.	187	18
Sepals or calyx-lobes 3–5.		
Flowers monœcious *Crotonopsis* (Genus)—Ord: Euphorbiaceæ.	263	5

	Page.	No. of Order.
Flowers perfect . . . . . . Plumbaginaceæ.	239	12
k. Stamens not of the same number as the petals, or if of the same number alternate with them. ***l.***		
l. **Calyx free from the ovary, i.e. ovary wholly superior.** ***m.***		
m. Ovaries 2 or more, wholly separate or somewhat united. ***n.***		
n. Stamens united with each other and with a large thick stigma common to the 2 ovaries . . . . Asclepiadaceæ.	242	15
n. Stamens free from each other and from the pistils. ***o.***		
o. Stamens on the receptacle, free from the calyx.		
Leaves punctate with translucent dots . . . . Rutaceæ.	199	30
Leaves without translucent dots.		
Trees or shrubs; leaves pinnate.		
Low shrub; leaflets mostly 5 *Zanthorhiza* (Genus)—Ord: Magnoliaceæ.	178	4
Tree; leaflets 11 or more . . . . . *Ailantus* (Genus).		
Herbs.		
Leaves fleshy . . . . Crassulaceæ.	212	3
Leaves not fleshy.		
Ovaries or lobes of the ovary 2–5, with a common style.		
Ovary 2–3-lobed . . *Limnanthaceæ*—Gentianaceæ	243	17
Ovary 5-lobed . . . . Geraniaceæ.	197	29
Ovaries with separate styles or sessile stigmas Ranunculaceæ.	174	1
o. Stamens inserted on the calyx.		
Plant fleshy; stamens just twice as many as the pistils Crassulaceæ.	212	3
Plant not fleshy; stamens not twice as many as the pistils.		
Stipules present . . . . Rosaceæ.	211	2
Stipules none . . . . *Saxifragaceæ*.		
m. Ovary 1. ***p.***		
p. Ovary simple with 1 parietal ventral placenta . . . . Leguminosæ.	204	1

	Page.	No. of Order.
Ovary compound, as shown by the number of its cells, placentæ, styles, or stigmas. *q*.		
***q*. Ovary 1-celled.**		
Corolla irregular.		
Petals 4; stamens 6 . . . . Fumariaceæ.	182	10
Petals and stamens 5 . . . . Violaceæ.	184	14
Corolla regular or nearly so.		
Ovule solitary.		
Trees or shrubs . . . . Anacardiaceæ.	203	35
Herbs . . . . Cruciferæ.	180	8
Ovules more than one.		
Ovules at the centre or bottom of the cell.		
Petals not inserted on the calyx . . . . Caryophyllaceæ.	187	17
Petals inserted on the throat of a bell-shaped or tubular calyx Lythraceæ.	219	9
Ovules on two or more parietal placentæ.		
Leaves punctate with translucent dots . . . Hypericaceæ.	188	20
Leaves beset with gland-tipped bristles . . . Droseraceæ.	213	4
Leaves neither punctate nor bristly-glandular.		
Petals 4.		
Stamens essentially equal; pod usually stiped Capparidaceæ.	181	9
Stamens unequal, 2 being shorter than the other 4; pod sessile. Cruciferæ.	180	8
Petals 3 or 5.		
Ovary stiped . . . . Passifloraceæ.	224	13
Ovary sessile.		
Calyx 5-lobed or of 5 equal sepals . . . *Saxifragaceæ.*		
Calyx of 3 equal or 5 very unequal sepals *Cistaceæ.*		
Petals 4 or 5 . . . . Tamaricaceæ.	188	19

	Page.	No. of Order.
q. Ovary 2–several-celled. ***r.***		
r. Flowers irregular. ***s.***		
s. Anthers opening at the top.		
Anthers 6–8, 1-celled . . . . Polygalaceæ.	186	16
Anthers 10, 2-celled . . Rhododendron (Genus)—Ord: Ericaceæ.	235	7
s. Anthers opening lengthwise.		
Stamens 12 and petals 6 on the throat of the gibbous calyx *Cuphea* (Genus)—Ord: Melastomaceæ.	221	12
Stamens 5–10 and petals hypogynous or nearly so.		
Ovary 3-celled; trees or shrubs *Æsculus* (Genus)—Ord: Sapindaceæ.	202	34
Ovary 5-celled: herbs . . . . *Balsaminaceæ Oxalidaceæ.*		
r. Flowers regular or nearly so. ***t.***		
t. Stamens neither just as many nor twice as many as the petals.		
Trees or shrubs.		
Stamens fewer than the 4 petals . . . . . Oleaceæ.	239	13
Stamens more numerous than the petals *Aceraceæ*—Sapindaceæ.	202	34
Filaments connate in a tube . . . . . . Meliaceæ.	200	31
Herbs.		
Petals 5 . . . . Hypericaceæ.	188	20
Petals 4 . . . . Cruciferæ.	180	8
t. Stamens just as many or twice as many as the petals. ***u.***		
u. Ovules and seeds only 1 or 2 in each cell.		
Herbs.		
Flowers monœcious or diœcious . . . . Euphorbiaceæ.	263	5
Flowers perfect and symmetrical.		
Cells of the ovary as many as the sepals.		
Ovary 2–3-celled . . *Limnanthaceæ*—Gentianaceæ.	243	17
Ovary 5-celled . . . . Geraniaceæ.	197	29

	Page.	No. of Order.
Cells of the ovary twice as many as the sepals.		
Leaves abruptly pinnate . . . . *Zygophyllaceæ.*		
Leaves simple . . . . Linaceæ.	196	27
Shrubs or trees.		
Leaves compound.		
Leaves 3-foliolate, punctate *Ptelea* (Genus)—Ord: Sapindaceæ.	202	34
Leaves pinnate, not punctate . . . . Sapindaceæ.	202	34
Leaflets oblique at the base . . . . Meliaceæ.	200	31
Leaves simple.		
Leaves palmately veined . . . *Aceraceæ*—Sapindaceæ.	202	34
Leaves pinnately veined.		
Leaves alternate.		
Climbing shrub . *Celastrus* (Genus)—Ord: *Celastraceæ.*		
Erect shrubs or trees.		
Flowers racemose . . . . . . *Cyrillaceæ.*		
Flowers solitary or cymose . . . *Aquifoliaceæ.*		
Leaves opposite . . . . *Celastraceæ.*		
Climbing Shrub . . . . . . Malpighiaceæ.	197	28
u. Ovules, and usually seeds, several or many in each cell. ***v.***		
v. Leaves compound.		
Tree or shrub . . . . *Staphyleaceæ.*		
Herbs; leaves alternate or all radical.		
Leaflets 3, obcordate . . . . *Oxalidaceæ*—Geraniaceæ.	197	29
Leaflets more numerous, pointed Astilbe (Genus)—Ord: *Saxifragaceæ.*		
Leaves simple.		
Stipules present between opposite leaves . . *Elatinaceæ.*		
Stipules none when the leaves are opposite.		
Stamens 5, united at the base into a 10-toothed cup or tube; leaves all radical *Galax* (Genus)—Ord: *Diapensiaceæ.*		

		Page.	No. of Order.
Stamens free from each other.			
Style 1.			
Stamens free from the calyx . . .	Ericaceæ.	235	7
Stamens inserted on the calyx . . .	Lythraceæ.	219	9
Styles 2–5, or splitting into 2 in fruit.			
Stamens free from the calyx; leaves opposite	Caryophyllaceæ.	187	17
Stamens inserted on the calyx . . .	Ericaceæ.	235	7
***l.* Calyx-tube adherent to the ovary, at least to its lower half.** *w.*			
w. Tendril-bearing and often succulent herbs	Cucurbitaceæ.	221	12
w. Not tendril-bearing.			
x. Ovules and seeds more than 1 in each cell.			
Ovary 1-celled.			
Sepals or calyx-lobes 2; ovules borne at the base of the ovary	Portulacaceæ.	187	18
Sepals or calyx-lobes 4 to 5; placentæ 2 to 3, parietal	*Saxifragaceæ.*		
Ovary 2–many-celled.			
Anthers opening by pores at the apex . . .	Melastomaceæ.	221	11
Anthers not opening by pores.			
Stamens inserted on or about a flat disk which covers the ovary	*Celastraceæ.*		
Stamens inserted on the calyx.			
Style 1; stamens 4 or 8 (rarely 5)	Onagraceæ.	220	10
Styles 2 to 3, distinct; stamens 5 or 10 . .	*Saxifragaceæ.*		
Stamens in anti-petalous pairs . . .	Rhizophoraceæ.	215	6
Stamens numerous; flowers hermaphrodite . .	Myrtaceæ.	217	8
Stamens numerous; flowers unisexual . . .	Begoniaceæ.	225	14
x. Ovules 2–3, seed only 1 in each cell	Combretaceæ.	216	7
x. Ovules and seeds only 1 in each cell.			
Stamens 5 or 10.			

	Page.	No. of Order.
Trees or shrubs.		
Leaves simple, not prickly *Cratægus* (Genus)—Ord.: Rosaceæ.	211	2
Leaves compound or prickly . . . . . . Araliaceæ.	228	17
Herbs.		
Fruit dry, splitting at maturity; styles 2 . . . Umbelliferæ.	226	16
Fruit berry-like; styles 2 to 5, separate or united . Araliaceæ.	228	17
Stamens, 2, 4, or 8.		
Style and stigma 1; fruit a drupe . . . . . Cornaceæ.	229	18
Styles or stigmatic branches or sessile stigmas usually more than 1; fruit not drupaceous.		
Shrubs or trees . . . . *Hamamelidaceæ.*		
Herbs.		
Style 1; stigma 2–4-lobed . . . . . . Onagraceæ.	220	10
Styles or sessile stigmas 4 . . . . . . Haloragaceæ.	21	5
d. **Petals more or less united.** *y.*		
y. Stamens more numerous than the lobes of the corolla. *z.*		
z. Ovary 1-celled.		
Placenta 1, parietal (ventral) . . . . Leguminosæ.	204	1
Placentæ 2, parietal . . . . Fumariaceæ.	182	10
Placenta at the centre or base of the ovary . . . . . Styracaceæ.	239	10
z. Ovary 2-celled; cells 1-ovuled . . . . Polygalaceæ.	186	16
z. Ovary 3–∞-celled. **A.**		
A. Stamens free from the corolla.		
Style 1; leaves simple . . . . Ericaceæ.	235	7
Styles 5; leaves 3-foliolate . . . . . *Oxalidaceæ*—Geraniaceæ.	197	29
A. Stamens attached to the base or tube of the corolla.		
Saprophytic herbs without green foliage . *Monotropoideæ* or Ericaceæ.	235	7
Not saprophytic; foliage green.		
Trees, shrubs, or under-shrubs; anthers mostly 2-celled		

		Page.	No of Order.
Filaments united into 1–5 groups.			
Ovary superior	Ternstrœmiaceæ.	190	22
Ovary at least partly inferior	Styracaceæ.	239	10
Filaments free from each other.			
Style 1	Ericaceæ.	235	7
Style 4	Ebenaceæ.	237	9
Filaments alternating with staminodia	Sapotaceæ.	235	8
Herbs; anthers 1-celled.			
Filaments united into a tube	Malvaceæ.	192	24
Filaments distinct, 2 at each notch of the corolla *Adoxa* (Genus)—Ord:	Caprifoliaceæ.	231	2
y. Stamens not more numerous than the corolla-lobes. **B.**			
B. Stamens of the same number as the corolla-lobes and opposite them.			
Corolla appendaged with scales inside; ovary 5-celled; trees or shrubs	Sapotaceæ.	235	8
Corolla not appendaged with scales inside; ovary 1-celled; herbs.			
Herbs; style 1; fruit a several-many-seeded capsule . .	*Primulaceæ.*		
Herbs; styles 5; fruit a 1-seeded utricle	Plumbaginaceæ.	239	12
Shrubs or trees	Myrsinaceæ.	238	11
B. Stamens alternate with the corolla-lobes or fewer. **C.**			
C. Ovary free from the calyx-tube (superior). D.			
D. Corolla regular. E.			
E. Stamens as many as the corolla-lobes. **F.**			
F. Ovaries more than 1, or, if 1, deeply-lobed.			
G. Ovaries 2, or, if 1, 2-horned.			
Stamens united	Asclepiadaceæ.	242	15
Stamens distinct.			
Stipules or stipular membrane or line between opposite leaves; ovary 2-horned	Loganiaceæ.	243	16

	Page	No. of Order.
Stipules none; ovaries 2.		
Leaves, kidney-shaped, alternate		
Dichondra (Genus)—Ord: Convolvulaceæ.	245	19
Leaves not kidney-shaped, chiefly opposite . Apocynaceæ.	239	14
G. Ovary deeply 4-lobed.		
Leaves alternate . . . . Boraginaceæ.	244	18
Leaves opposite . . . . Labiatæ.	250	22
F. Ovary 1, not deeply lobed.		
H. Ovary, 1-celled.		
Seed 1; corolla scarious . . . . . *Plantaginaceæ.*		
Seeds several to many.		
Leaves entire, opposite . . . . . . Gentianaceæ.	243	17
Leaves toothed, lobed, or compound.		
Whole upper surface of corolla white-bearded; leaflets 3, entire . . *Menyanthes* (Genus)—Ord: Gentianaceæ.	243	17
Corolla not conspicuously bearded; leaves, if compound, with toothed leaflets . *Hydrophyllaceæ*—Gentianaceæ.	243	17
H. Ovary, 2–10-celled.		
Leafless twining parasites		
Cuscuta (Genus)—Ord: Convolvulaceæ	245	19
Leaves opposite, their bases connected by a stipular line		
Loganiaceæ.	243	16
Leaves alternate, or, if opposite, with no trace of stipules.		
Stamens free from the corolla or nearly so.		
Style 1 . . . . Ericaceæ.	235	7
Style none . . . . *Aquifoliaceæ.*		
Stamens in the notches of the corolla; style 1 *Diapensiaceæ.*		
Stamens on the tube of the corolla.		
Stamens 4.		

	Page.	No. of Order.
Leafy-stemmed; leaves opposite, corolla petaloid Verbenaceæ.	252	23
Acaulescent; corolla scarious . . *Plantaginaceæ.*		
Stamens 5, or rarely more.		
Fruit of 2 or 4 seed-like nutlets . . . Boraginaceæ.	244	18
Fruit a few to many-seeded-pod.		
Styles 3 (rarely in) *Brewena* (Genus)—Ord: Convolvulaceæ.	245	19
Styles 2.		
Pod few- (mostly 4) seeded . . Convolvulaceæ.	245	19
Pod many-seeded . *Hydrophyllaceæ*—Gentianaceæ.	243	17
Style 1, often branched.		
Branches of the style (or at least the lobes of stigma) 3.		
Not twining . . . . . . *Polemoniaceæ.*		
Twining Ipomœa (Genus)—Ord: Convolvulaceæ.	245	19
Branches of the style or lobes of the stigma 2 or rarely 4.		
Seeds few, mostly 4 . . . . Convolvulaceæ.	245	19
Seeds many . . . . . . Solanaceæ.	247	20
E. Stamens fewer than the corolla-lobes.		
Stamens with anthers 4, in pairs.		
Ovary 2-celled; cells several-seeded . . . . Acanthaceæ.	249	21
Ovary 2–4-celled; cells 1-seeded . . . . Verbenaceæ.	252	23
Stamens with anthers only 2 or rarely 3.		
Ovary 4-lobed . . . . *Lycopus* (Genus)—Ord: Labiatæ.	250	22
Ovary 2-celled, not 4-lobed.		
Herbs.		
Acaulescent; corolla scarious . . . *Plantaginaceæ.*		
Leafy-stemmed; corolla not scarious Veronica (Genus)—Ord: Scrophulariaceæ.	253	24
Trees or shrubs . . . . Oleaceæ.	239	13

D. Corolla irregular. I.	Page.	No. of Order.
I. Stamens with anthers 5.		
Stamens free from the corolla; anther-cells opening at the apex		
Rhododendron (Genus)—Ord: Ericaceæ.	235	7
Stamens inserted on the corolla.		
Ovary deeply 4-lobed around the style		
Echium (Genus)—Ord: Boraginaceæ.	244	18
Ovary not deeply lobed, many ovuled.		
Filaments or some of them woolly		
Verbascum (Genus)—Ord: Scrophulariaceæ.	253	24
Filaments not woolly Hyoscyamus (Genus)—Ord: Boraginaceæ.	244	18
I. Stamens with anthers 2 or 4.		
Ovules solitary in the 1–4 cells.		
Ovary 4-lobed; style rising from between the lobes (gynobasic or basilar) . . . . Labiatæ.	250	22
Ovary not lobed; style from its apex.		
Ovary 1-celled; fruit turned downwards		
Phryma (Genus)—Ord: Verbenaceæ.	252	23
Ovary 2–4-celled; fruit not turned downwards . Verbenaceæ.	252	23
Ovules 2–many in each cell.		
Ovary imperfectly 4–5-celled . . . . . *Martyniaceæ.*		
Ovary 1–2-celled.		
Ovary 1-celled.		
Parasites without green foliage, terrestrial; stamens 4		
Orobanchaceæ.	255	25
Not parasitic, chiefly aquatic or mud plants; stamens 2		
Lentibulariaceæ—Utriculariaceæ.	255	26
Ovary 2-celled.		
Trees or woody climbers; placentæ parietal . Bignoniaceæ.	257	28

	Page.	No. of Order.
Herbs or shrubs; placentæ parietal . . . Gesneraceæ.	256	27
Herbs, rarely trees: placentæ in the axis.		
Seeds (mostly numerous) not borne on hooks Scrophulariaceæ.	253	24
Seeds (2 to 12) borne on hook-like processes of the placentæ Acanthaceæ.	249	21
C. Ovary adherent to the calyx-tube (inferior). J.		
J. Tendril-bearing herbs; anthers often united . . . Cucurbitaceæ.	221	12
J. Tendrils none. **K.**		
K. Stamens separate.		
L. Stamens free from the corolla or nearly so, as many as its lobes; stipules none; juice milky . . . Campanulaceæ.	235	5
L. Stamens inserted on the corolla.		
Stamens 1 to 3, always fewer than the corolla-lobes Valerianaceæ.	231	3
Stamens 4 to 5; leaves opposite or whorled.		
Ovary 2–5-celled.		
Leaves opposite or perfoliate, but neither whorled nor provided with true stipules . . . . . . Caprifoliaceæ.	231	2
Leaves either opposite and stipulate, or whorled and destitute of stipules . . . . Rubiaceæ.	229	1
Ovary 1-celled; flowers in dense involucrate heads *Dipsaceæ.*		
K. Stamens united by their anthers; these joined in a ring or tube.		
Flowers separate, not involucrate; corolla irregular *Lobeliaceæ*—Campanulaceæ.	235	5
Flowers in an involucrate head . . . . . . Compositæ.	232	4

GLOSSARY

Abortion, imperfect development or non-development of an organ.

Abortive, defective or barren.

Achene, a small dry and hard one-celled, one-seeded indehiscent fruit, seed adhering to the pericarp.

Achlamydeous, without calyx and corolla.

Acicular, slenderly needle-shaped.

Aclinomorphic (flower), capable of being divided into equal and symmetrical halves by any number of vertical planes passing through the centre of a flower; polysymmetrical.

Acuminate, tapering at the end.

Acute, terminating with a sharp or well-defined angle.

Acyclic (flower), sepals, petals, stamens, and carpels inserted spirally on the thalamus.

Adhesion, union of one organ with another of a dissimilar nature.

Adnate, united, as the inferior ovary, with the cup-shaped thalamus commonly known as the calyx-tube. **Adnate** or **dorsifixed anther**, one attached to the filament at its back.

Aestivation, the arrangement of the parts of the perianth in the flower-bud.

Albumen, any deposit of nutritive material accompanying or outside the embryo.

Albuminous, having albumen.

Alternate (of leaves, &c.), not opposite to each other on the axis, but arranged singly at different heights.

Ambi-sporangiate (flower), having both stamens and pistil.

Ament, a catkin, or scaly spike, usually drooping, with unisexual flowers.

Amplexicaul, clasping the stem.

Anastomosing, connecting by cross veins or filaments and forming a network.

Anatropous (ovule), inverted and straight, with the micropyle nearest to the placenta and the chalaza farthest from the placenta.

Andrœcium: collective term for all the stamens of a flower.

Androgynous (inflorescence), composed of both staminate and pistillate flowers.

Androphore, stalk, that is, internode between corolla and andrœcium which bears the andrœcium.

-androus, in composition, having stamens.

Anemophilous, wind-loving; pollination brought about by wind.

Angiospermous, having the seeds borne within a pericarp or closed ovary.

Annual, of only one year's duration.

Annular, in the form of a ring.

Anterior, on the front side of a flower and next the bract, remote from the axis of inflorescence; equivalent to inferior and (less properly) exterior.

Anther, the polliniferous part of a stamen.

Antheriferous, anther-bearing.

Anthesis, the time of expansion of a flower.

Apetalous, having no petals.

Apocarpous (pistil), when it is composed of one carpel, or more carpels than one but all free.

Aquaphilous, water-loving; pollinated by water.

Arborescent, tree-like.

Aril, an appendage growing at or about the hilum of a seed, wholly or partially covering it.

Arillate, having an aril.

Articulate, jointed; having a node or joint.

Ascending, rising somewhat obliquely, or curving upward. **Ascending ovule**, one that is attached above the base of the ovary and is directed upward.

Ascidia, pitchers, utricles.

Asymmetrical (flower). Incapable of being divided into equal and symmetrical halves by any plane of symmetry.

Auriculate, furnished with auricles.

Awl-shaped, tapering upward from the base to a slender or rigid point.

Awn, a bristle-shaped appendage, as the awned palea of some rice.

Axil, the angle formed by a leaf or branch with the stem.

Axile, situated in the axis; placenta in the axis of the ovary, also called central.

Axillary, situated in an axil.

Axis, the central line of any organ or support of a group of organs; a stem, &c.

Baccate, berry-like; pulpy throughout.

Basifixed or **innate anther**, one attached to the filament by the base, so that the connective is the direct prolongation of the filament.

Bast, the fibrous portion of the inner bark.

Berry, a fruit the whole pericarp of which is fleshy or pulpy, with many seeds.

Bi- or **bis-**, a Latin prefix signifying two, twice, or doubly.

Biennial, of two years' duration.

Bifid, two-cleft.

Bilabiate, two-lipped.

Bilocular, two-celled.

Bisexual, having both stamens and pistils.

Blade, the expanded portion of a leaf, &c.

Bract, a more or less modified leaf subtending a flower or belonging to an inflorescence.

Bracteate, having bracts.

Bracteole, bractlet.

Bracteolate, having bractlets.

Bractlet, a secondary bract, as one upon the pedicel of a flower.

Bud,. the rudimentary state of a stem or branch; an unexpanded flower.

Bulb, a subterranean leaf-bud with fleshy scales or coats.

Bulbiferous, bearing buds.

Bulbil, a small bulb, especially one borne upon the stem, and falling off naturally and reproducing vegetatively.

Bulbous, having the character of a bulb.

Caducous, falling off very early.

Calyx, the outer perianth of the flower.

Campanulate, bell-shaped; cup-shaped with a broad base.

Campylotropous (ovule or seed), so curved as to bring the apex and base nearly together, so that the micropyle and the chalaza are at the same level.

Capillary, hair-like.

Capitate, shaped like a head; collected into a head or dense cluster.

Capitulum, raceme with floral axis developed radially, forming a flat, concave, convex, or jug-shaped receptacle on or within which are inserted the florets, usually embraced below by an involucre of bracts.

Capsular, belonging to or of the nature of a capsule.

Capsule, a dry dehiscent fruit composed of more than one carpel.

Carinal, on or having relation to a ridge or keel.

Carpel, a simple pistil, or one member of a compound (syncarpous) pistil, or of a multiple pistil.

Carpophore, the slender prolongation of the floral axis which in the *Umbelliferæ* supports the pendulous ripe carpels.

Caryopsis, a grain, as of grasses; a seed-like fruit with a thin pericarp adnate to the contained seed.

Catkin, an ament.

Caudate, having a slender tail-like appendage.

Caudex, the persistent base of an otherwise annual herbaceous stem, or an unbranched stem generally, as of a Palm.

Caudicle, the thread-like or strap-shaped stalk of a pollinium.

Caulescent, having a manifest stem above ground.

Cauline, belonging to the stem.

Cell, one of the minute vesicles, of very various forms, of which plants are formed. Any structure containing a cavity, as the cells of an anther, ovary, &c.

Cellular (tissue), composed of short transparent thin-walled cells, in distinction from fibrous or vascular.

Chlorophyll, the green colouring-matter within the cells of plants.

Cilia, hairs.

Ciliate, fringed with hairs; hairy.

Circinate, coiled from the top downward, as the young frond of a Fern.

Circumscissile, dehiscing in a regular transverse circular line of division.

Cleistogamous, fertilized in the bud, without the opening of the flower.

Coccus (*pl.* **cocci**), one of the parts into which a lobed fruit with 1-seeded cells splits.

Cohesion, the union of one organ with another of like nature.

Coma, a tuft of hairs.

Compound, composed of two or more similar parts united into one whole. **Compound leaf**, one divided into separate leaflets.

Compressed, flattened, especially laterally.

Conduplicate, folded together lengthwise, like the leaves of a book.

Coniferous, cone-bearing.

Conjugation, fusion of the undifferentiated male and female elements.

Connate, united; used especially of like structures joined from the start.

Connective, the portion of a stamen which connects the two lobes of the anther, corresponding to the mid-rib of the blade of a leaf.

Connivent, coming into contact; converging.

Convolute, rolled up longitudinally from one margin to the other, like a map.

Cordate, heart-shaped with the point upward.

Coriaceous, leathery in texture.

Corm, the enlarged fleshy base of a stem, bulb-like but solid.

Corolla, the inner perianth of distinct or connate petals.

Corona, an inner appendage to a petal, or to the throat of a corolla.

Corymb, a flat-topped or convex open flower-cluster; in the stricter use of the word equivalent to a raceme, with the flowers borne upon pedicels which are successively shorter from the base to the apex, so that the flowers have a flat or nearly flat top, and progressing in its flowering from the margin inward.

Corymbose, in corymbs, or corymb-like.

Costa, a rib, a mid-rib or mid-nerve.

Costate, ribbed, having one or more longitudinal ribs or nerves.

Cotyledons, the foliar portion of first leaves (one, two, or more) of the embryo, as found in the seed.

Creeping, running along at or near the surface of the ground, and rooting at the nodes specially.

Crenate, dentate with the teeth rounded.

Crenulate, finely crenate.

Cruciate, cross-shaped.

Culm, the peculiar stem of Sedges and Grasses.

Cuneate, wedge-shaped; triangular with the acute angle downward.

Cuspidate, tipped with a *cusp* or sharp and rigid point.

Cyclic (flower), sepals, petals, stamens, and carpels inserted on the thalamus in whorls.

Cyme, a usually broad and flattish determinate or definite inflorescence, i.e. with its central or terminal flowers blooming earliest.

Cymose, bearing cymes, or cyme-like.

Deciduous, not persistent, not evergreen.

Decompound, more than thrice compound or divided.

Decurrent (leaf), extending down the stem below the insertion.

Decussate, alternating in pairs at right angles.

Dehiscent, opening regularly by valves, slits, &c., as a capsule or anther.

Dentate, toothed, usually with the teeth directed outward.

Di-, Dis-, a Greek prefix signifying two or twice.

Diadelphous (stamen), filaments combined in two sets, anthers remaining free.

Diandrous, having two stamens.

Dicarpellary, composed of two carpels.

Dichogamous (flower), stamens and pistil mature at different times.

Dichotomous, forking regularly by pairs; true, when the bud is divided into two parts; false, when the terminal bud is aborted and two lateral buds, one on either side, grow (*dichasium*).

Diclinous, having only stamens or pistil, not both.

Dicotyledonous, having two cotyledons.

Didymous, twin, found in pairs.

Didynamous (stamens), in two pairs of unequal length.

Diffuse, widely or loosely spreading.

Digitate, compound, with the members arising together at the apex of the support, and the outer members forming acute angles with the support.

Dimerous (flower), having all the parts in twos.

Dimorphous, occurring in two forms; usually applied to flowers in which stamens and styles are of two different lengths.

Diœcious, unisexual, with the two kinds of flowers on separate plants.

Discoid, resembling a disk.

Disk, a development of the receptacle at or around the base of the pistil.

Dissected, cut or divided into numerous segments.

Dissepiment, a partition in an ovary or fruit.

Distichous, in two vertical ranks.

Distinct, separate, not united, evident.

Divaricate or **Distractile**, widely divergent.

Divided, lobed to the base.

Dorsal, upon or relating to the back or outer surface of an organ.

Dorsiventral, with distinction of back and front, or placed with reference to the back and the front.

Drupaceous, resembling or of the nature of a drupe.

Drupe, a fleshy or pulpy fruit with the inner portion of the pericarp (one-celled and one-seeded, or sometimes several-celled) hard or stony.

Drupelet, a diminutive drupe.

E- or **ex-**, a Latin prefix having often a privative signification, as **ebracteate**, without bracts.

Ecological, concerning the relation of plants to their surroundings.

Emarginate, having a shallow notch at the extremity.

Embryo, the rudimentary plantlet within the seed; the baby plant.

Embryo-sac, enlarged cell of the nucellus, within which is developed the embryo.

Endocarp, the inner layer of a pericarp.

Entire, without toothing or division.

Entomophilous (flower), insect-loving; pollination brought about by insects.

Epicarp, the outer layer of the pericarp or matured ovary.

Epidermis, the superficial layer of cells.

Epigynous, growing on the summit of the ovary, or apparently so.

Epiphyte, a plant growing attached to another plant, but not parasitic; an air-plant.

Equitant, astride; used of conduplicate leaves, which enfold each other in two ranks, as in Iris.

Exalbuminous, without albumen.

Exserted, projecting beyond an envelope, as stamens from a corolla.

Extrorse, facing outward, as extrorse anther.

Falcate, scythe-shaped; curved and flat, tapering gradually.

Farinaceous, containing starch; starch-like.

Fascicle, a close bundle or cluster.

Fasciculate, in close bundles or clusters.

Fertile, capable of producing fruit; or productive, as a flower having a pistil, or an anther with pollen.

Fertilization, fusion of the male element with the female element when they are differentiated.

Fibrous, composed of or resembling fibres. **Fibrous tissue**, a tissue formed of elongated, thick-walled cells.

Fibro-vascular, composed of woody fibres and ducts or other vessels.

Filament, the part of a stamen which supports the anther; any thread-like body.

Filamentous, composed of threads.

Filiform, thread-shaped; long, slender, and terete.

Fimbriate, fringed.

Fistular, hollow and cylindrical.

Flaccid, without rigidity; lax and weak.

Floret, a small flower, usually one of a dense cluster.

Foliaceous, leaf-like in texture or appearance.

Follicle, a fruit consisting of a single carpel, dehiscing by the ventral suture; occasionally dorsal, as in Magnolia.

Follicular, like a follicle.

Forked, divided into nearly equal branches.

Free, not adnate to other organs.

Free central placenta, situated in the centre or axis of the ovary, free from or unconnected with the wall of the ovary.

Fruit, the seed-bearing product of a plant; simple, compound,

or aggregated, of whatever form.

Fugacious, falling or fading very early.

Funicle the free stalk of an ovule or seed.

Fusiform, spindle-shaped; swollen in the middle and narrowing towards each end.

Gamopetalous, having the petals of the corolla more or less united.

Gamophyllous, composed of coalescent leaves or leaf-like organs, usually applied to the perianth leaves.

Gamosepalous, having the sepals united.

Gibbous, protuberant or swollen on one side.

Glabrous, smooth; not rough, pubescent, or hairy.

Gland, a secreting surface or structure; any protuberance or appendage having the appearance of such an organ.

Glandular, bearing glands or of the nature of a gland.

Glaucous, covered or whitened with a bloom.

Glumaceous, furnished with or resembling glumes.

Glume, a chaff-like bract; specially one of the two empty, chaffy bracts at the base of the spikelet in the Grasses.

Gymnospermous, bearing naked seeds, without an ovary or closed carpellary leaf.

Gynæcium: The pistil of a flower; or all the pistils, collectively.

Gynandrophore, the stalk-like internode supporting both the andrœcium and gynæcium.

Gynandrous, having the stamens adnate or adherent to the pistil, as in *Orchidaceæ*,

Gynophore, the stalk-like internode supporting the gynœcium only.

Gynostemium, the compound structure or column resulting from the union of the stamens and pistil in the *Orchidaceæ*.

Habit, the general appearance of a plant.

Habitat, locality, geographical position.

Hastate, dart-shaped or like an arrow-head, but with the basal lobes pointing outward nearly at right angles.

Head, a dense cluster of sessile or nearly sessile flowers on a very short axis or receptacle.

Heart-shaped, ovate, with two rounded lobes and a sinus at base; commonly used to define such a base.

Helicoid (cyme), one-sided cyme circinately coiled.

Herb, a plant with no persistent woody stem above ground.

Herbaceous, having the characters of a herb; leaf-like in colour and texture; soft in texture.

Herkogamous, having self-pollination prevented by suitable contrivances in homogamous flowers.

Hermaphrodite, flowers with both stamens and pistil.

Heterogamous, bearing two kinds of flowers.

Heterostylism, condition in flowers in which the styles and stamens are of different lengths.

Hilum, the scar left at point of attachment of the seed to its funicle when the seed falls off.

Hirsute, pubescent with rather coarse or stiff hairs.

Hispid, beset with rigid or bristly hairs or with bristles.

Homogamous, bearing but one kind of flowers; also when both the sexes in a flower mature at the same time.

Hyaline, transparent or translucent.

Hybrid, a cross breed of two species.

Hypocrateriform (corolla), salver-shaped regular gamopetalous corolla with a long tube and spreading limbs.

Hypogynous, inserted on the thalamus beneath the ovary and free from it; having the sepals, petals, and stamens so inserted.

Imbricate, overlapping, either vertically or spirally, where the lower piece covers the base of the next higher; or laterally, as in the æstivation of a calyx or corolla, where at least one piece must be wholly external and one internal.

Impari-pinnate (leaf), pinnate with a terminal leaflet.

Incised, cut sharply and irregularly more or less deeply.

Included, not protruded from the surrounding envelope.

Indefinite (stamens, &c.), very numerous.

Indehiscent, not opening by valves, &c.; remaining persistently closed.

Inferior, lower or below; outer or anterior. **Inferior ovary**, one that is adnate to the calyx.

Inflated, bladdery.

Inflorescence, the flowering axis or branch of a plant, and especially the mode of its arrangement.

Innate or **basifixed**, filament attached to the base of the anther, so that the filament and the connective are in the same straight line.

Inserted, attached to or growing out of.

Inter-, in composition, between.

Internode, the portion of a stem between two nodes.

Interpetiolar, between the leaves of a pair, as the stipules of many *Rubiaceæ*.

Intramarginal, within and near the margin.

Intrapetiolar, inside, or in the axil of the petiole or leaf, as intrapetiolar stipule; also axillary.

Introrse, turned inward or toward the axis (as introrse anthers).

Involucel, a secondary involucre, as that of an umbellet in *Umbelliferæ*.

Involucellate, having an involucel.

Involucral, belonging to an involucre.

Involucrate, having an involucre.

Involucre, a circle or collection of bracts surrounding a flower-cluster or head, or a single flower.

Involute, rolled inward longitudinally from the margin.

Irregular (flower), showing inequality in the size, form, or union of its similar parts.

Keel, a central dorsal ridge, like the keel of a boat; the two anterior united petals of a papilionaceous flower.

Labellum, lip; the peculiar upper (but by a twist of the pedicel apparently lower) petal of the *Orchidaceæ*.

Labiate, lipped; belonging to the *Labiatæ*.

Lanceolate, shaped like a lance-head, several times longer than wide, broadest above the base and narrowed to the apex.

Leaflet, a single division of a compound leaf.

Legume, the fruit of the *Leguminosæ*, formed of a simple pistil, and usually dehiscent by both sutures.

Ligulate, furnished with a ligule.

Ligule, a strap-shaped corolla, as in the ray flowers of *Compositæ*; a thin often scarious or hairy projection from the summit of the sheath in Grasses, facing the stem.

Limb, the free portion of a gamopetalous corolla.

Linear, long and narrow, with parallel margins.

Lip, each of the upper and lower divisions of a bilabiate corolla, or calyx; the peculiar upper (but by the twist of the pedicel apparently lower) petal in Orchids.

Lobe, any segment of an organ.

Lobed, divided into or bearing lobes.

Locular, in composition, having cells.

Loculicidal, dehiscent into the cavity of a cell through the dorsal suture.

Lunate, of the shape of a half-moon or crescent.

Lyrate, pinnatifid with a large and rounded terminal lobe, and with the lower lobes small.

Macrosporangium, the receptacle in which macrospores are developed; ovules of Phanerogamia.

Membranous, thin, rather soft, and more or less translucent.

Mericarp, one of the achene-like carpels of *Umbelliferæ*.

-merous. In composition, having parts, as 2-merous, having two parts of each kind.

Micropyle, the point upon th seed at which was the orifice of the ovule.

Microsporangium, the receptacle in which microspores are developed; pollen-sac in Phanerogamia.

Mid-rib, the central or main rib of a leaf.

Monadelphous (stamens), united by their filaments into a tube or column, anthers remaining free.

Moniliform, resembling a string of beads; cylindrical with contractions at intervals.

Monoclinous, having both stamen and pistil; hermaphrodite or bisexual.

Monocotyledonous, having but one cotyledon.

Monœcious, with stamens and pistils in separate flowers on the same plant.

Monopodial, having the axis formed from one bud, uniaxial.

Mucronate, tipped with a mucro or short and sharp abrupt tip.

Nectariferous, producing nectar or bearing nectary.

Nectary, any place or organ where nectar is secreted.

Nerve, a simple or unbranched vein or slender rib.

Neuter, neutral, without stamens or pistils.

Node, the place or ring upon a stem which normally bears a leaf or a whorl of leaves.

Nut, a hard indehiscent one-celled and one-seeded fruit, though usually resulting from a compound ovary.

Nutlet, a diminutive nut.

Ob-; a Latin prefix, usually carrying the idea of inversion.

Obconically, inversely conical, having the attachment at the apex.

Obcordate, inverted heart-shaped.

Oblanceolate, lanceolate with the broadest part toward the apex.

Oblique, unequal-sided or slanting.

Oblong, longer than broad, and with nearly parallel sides.

Obovate, inverted ovate.

Obovoid, having the form of an inverted egg.

Obsolete, not evident, rudimentary.

Obtuse, blunt or rounded at the end.

Ocrea, a legging-shaped or tubular stipule.

Ocreate, having sheathing stipules.

Officinal, of the shops; used in medicine or the arts.

Oosphere, unfertilized germ-cell.

Oospore, the fertilized germ-cell from which the new plant is directly developed; the product of fertilization.

Opaque, dull; neither shining nor translucent.

Operculum, a lid; the upper portion of a circumscissile capsule.

Orbicular, circular.

Orthotropous (ovule or seed), erect, with the orifice or micropyle at the apex farthest from the placenta and the chalaza nearest to the placenta.

Ovary, the part of the pistil that contains the ovules.

Ovate, egg-shaped; having an outline like that of an egg, with the broader end downward.

Ovoid, a solid with an oval outline.

Ovule, the body which after fertilization becomes the seed.

Ovuliferous, bearing ovules.

Palate, a rounded projection of the lower lip of a personate corolla, closing the throat.

Palea, glume or bract which with the flowering glume encloses the flower in Grasses; also the bracts on the disk of a capitulum.

Paleaceous, chaffy.

Palmate (leaf), compound leaf with the leaflets attached to the apex of the petiole and

spreading like the fingers of a palm.

Palmately-lobed (leaf), simple, palmi-veined, lobed leaf: **palmi-fid, -partite,** or **-sect,** in order of the depths of the indentations.

Panicle, branched or compound raceme.

Panicled, borne in a panicle, resembling a panicle.

Papilionaceous (corolla), having a standard, wings, and keel, as in the peculiar corolla of many *Leguminosæ*.

Papillose, bearing minute nipple-shaped projections.

Pappus, the modified calyx-limb in *Compositæ*, forming a crown of hair at the summit of the achene.

Parasitic, growing on and deriving nourishment from another plant or animal.

Pari, equally, that is, without terminal leaflet.

Parietal, borne on or pertaining to the wall or inner surface of a capsule, as parietal placenta.

Parthenogenetic, developing without fertilization.

Pedate, palmately divided or parted, with the lateral segments 2-cleft and inclined towards the foot or stalk of leaf.

Pedicel, the support of a single flower.

Pedicellate, borne on a pedicel.

Peduncle, a primary flower-stalk, supporting either a cluster or a solitary flower.

Pedunculate, borne upon a peduncle.

Pellucid, clear, transparent.

Peltate, shield-shaped and attached to the support by the lower surface.

Pendulous, more or less hanging or declined. **Pendulous ovule,** one that hangs from the side of the cell.

Perennial, lasting year after year.

Perfect (flower), having both pistil and stamens.

Perfoliate (leaf), having the stem apparently passing through it.

Perianth, the floral envelope, consisting of the calyx and corolla (when present), whatever their form. Usually applied to calyx and corolla both when they are of the same colour, and when only one whorl is present, calyx or corolla.

Pericarp, the wall of the matured ovary.

Perigynous, adnate to the perianth, and therefore around the ovary and not at its base.

Persistent, long-continuous, as a calyx upon the fruit, leaves through winter, &c.

Personate (corolla), bilabiate, with the throat closed by a prominent palate.

Petal, a division of the corolla.

Petaloid, coloured and resembling a petal.

Petiolate, having a petiole.

Petiole, the footstalk of a leaf.

Phanerogamous or **Phænogamous,** having flowers with stamens and pistils and producing seeds.

Phyllodium (*pl.* **phyllodia**), a somewhat dilated petiole having the form of and serving as a leaf-blade.

Pilose, hairy, especially with soft hairs.

Pinna (*pl.* **pinnæ**). One of the primary divisions of a simple pinnate or compoundly pinnate frond or leaf.

Pinnate (leaf), compound, with leaflets arranged on each side of a common petiole or rachis.

Pinnati-fid, -partite, -sect (leaf), pinni-veined, pinnately-lobed, simple leaf, the sinuses being respectively less, more, or most deep.

Pistil, the seed-bearing organ of the flower, consisting of the ovary, stigma, and style when present.

Pistillate, provided with pistil, and, in its more restricted sense, without stamens.

Pitcher, pitcher-like structures; also called *ascidium* or *utricle*.

Pitted, marked with small depressions or pits.

Placenta, any part of the interior of the ovary which bears ovules.

Plicate, folded into plaits, usually lengthwise.

Plumule, the first bud or growing point of the embryo.

Pod, any dry and dehiscent long fruit.

Pollen, the fecundating grains contained in the anther.

Pollination, contact of the ripe pollen with the mature stigma in Angiosperms or with the ovule directly in Gymnosperms.

Polliniferous, bearing pollen.

Pollinium (*pl.* **pollinia**), a mass of waxy pollen or of coherent pollen-grains, as in *Asclepiadaceæ* and *Orchidaceæ*.

Polyadelphous (stamens), filaments combined in many bundles, anthers remaining free.

Polypetalous, having separate petals.

Pome, a kind of fleshy fruit of which the apple is the type (a kind of *berry*).

Porous, pierced with small holes or pores.

Posterior, in an axillary flower, the side nearest to the axis of inflorescence.

Prickle, a small spine or more or less slender sharp outgrowth from the bark or rind, easily separable from it.

Procumbent, lying on the ground or trailing but without rooting at the nodes.

Proliferating, **proliferous**, producing offshoots.

Prostrate, lying flat upon the ground.

Protandrous, having the anthers ripe before the maturity of the stigma, of hermaphrodite flowers.

Protogynous, having the stigma ripe for the pollen before the maturity of the anthers, of hermaphrodite flowers.

Pubescent, covered with hairs, especially if short, soft, and down-like.

Pyriform, pear-shaped.

Raceme, a simple inflorescence of equally or nearly equally pediceled flowers upon a common more or less elongated axis.

Racemose, in racemes, or resembling a raceme.

Rachis, the axis of a spike,

raceme, or corymb, or of a compound leaf.

Radical, belonging to or proceeding from the root or base of the stem near the ground.

Radicle, the portion of the embryo below the cotyledons.

Ramification, branching.

Raphe, the ridge or adnate funicle which in an anatropous ovule connects the two ends.

Ray, the branch of an umbel; the marginal flowers of an inflorescence when distinct from the disk flowers (as in capitulum).

Receptacle, the more or less expanded or produced portion of an axis which bears flowers in the form of a head.

Regular, uniform in shape or structure.

Reniform, kidney-shaped.

Repand, with a slightly wavy and somewhat sinuate margin.

Reticulate, in the form of network; net-veined.

Revolute, rolled backward from the margins.

Rhizome, any prostrate or subterranean stem, usually rooting at the nodes and becoming erect at the apex.

Rib, a vein of a leaf.

Root, the underground part of a plant which supplies it with nourishment.

Rootstock, same as Rhizome.

Rostellum, a little beak; a slender extension from the upper edge of the stigma in Orchids.

Rosulate, in the form of a rosette.

Rotate (corolla), wheel-shaped regular gamopetalous corolla; flat and circular in outline with a short tube.

Runner, a filiform or very slender stolon.

Saccate, sac-shaped.

Sagittate, shaped like an arrow-head, the basal lobes directed downward.

Samara, an indehiscent winged fruit.

Scabrous, rough to the touch.

Scape, a peduncle rising from the ground, naked or without proper foliage, bearing one or more flowers.

Scapigerous, bearing a scape.

Scarious, thin, dry, and membranaceous; not green.

Scorpioid (inflorescence), alternate-sided cyme, circinately coiled while in bud.

Seed, the ripened ovule, consisting of the embryo and its proper coats.

Segment, one of the parts of a leaf or other like organ that is cleft or divided.

Sepal, a division of a calyx.

Septate, divided by partitions.

Septicidal (capsule), dehiscing through the partitions or septas and between the cells.

Septum, any kind of partition.

Serrate, having sharp teeth pointing upward.

Serrulate, finely serrate.

Sessile, without footstalk of any kind.

Sheath, a tubular envelope, as the lower part of the leaf in Grasses.

Sheathing, inclosing as by a sheath.

Shrub, a woody perennial, smaller than a tree, usually with several stems.

Silicula, a short siliqua.

Siliqua, the peculiar pod of *Cruciferæ*.

Simple, of one piece; not compound.

Sinuate, with the outline of the margin strongly wavy.

Sinus, the cleft or recess between two lobes.

Spadix, a spike with a fleshy axis enclosed by a spathe.

Spathe, bract or bracts inclosing an inflorescence.

Spatulate, gradually narrowed downward from a rounded summit; spatula-shaped.

Spike, a form of simple inflorescence with the flowers sessile or nearly so upon a more or less elongated common axis or rachis.

Spikelet, a small or secondary spike.

Spindle-shaped, same as Fusiform.

Spine, a sharp, woody, or rigid outgrowth from the stem.

Spinose, spine-like, or having spines.

Spore, the reproductive cell in Cryptogams, which in function corresponds to a seed but possesses no embryo.

Spur, a hollow, sac-like or tubular extension of some part of a blossom, usually nectariferous.

Stamen, one of the pollen-bearing organs of the flower.

Staminode or **staminodium**, a sterile stamen, or any structure, without anther, corresponding to a stamen.

Standard, the upper dilated petal of a papilionaceous corolla.

Stem, the main ascending axis of a plant.

Sterile, unproductive, as a flower without pistil, or stamen without an anther.

Stigma, that part of a pistil through which fertilization by the pollen is effected.

Stigmatic, belonging to or characteristic of the stigma.

Stipe, the stalk-like support of a pistil, that is, the gynophore; the leaf-stalk of a Fern.

Stipitate, having a stipe.

Stipular, belonging to stipules.

Stipule, an appendage at the base of a petiole or on each side of its insertion.

Stolon, a runner, or any basal branch that is disposed to root.

Stoloniferous, producing stolons.

Style, the usually attenuated portion of the pistil connecting the stigma and ovary.

Sub-, a Latin prefix, usually signifying somewhat or slightly.

Subulate, awl-shaped.

Succulent, juicy; fleshy.

Superior (ovary), free from the calyx.

Supra-axillary, borne above the axil.

Suspended (ovule), hanging from the apex or the cell.

Suture, a line of junction.

Symbiotic, living a life of mutual help.

Symmetrical (flower), regular as to the number of its parts;

having the same number of parts in each whorl.

Sympodial, having the axis formed of several axes or buds; multi- or joint-axial.

Syncarpous, (pistil), made up of two or more carpels united together.

Syngenesious, anthers joined in a tube, filaments remaining free.

Tendril, thread-like structures helping plants to climb.

Teratological, monstrous; relating to a monstrosity.

Terete, having a circular transverse section.

Ternate, in threes.

Testa, the outer commonly hard and brittle seed-coat.

Tetradynamous, having four long and two shorter stamens.

Thalamus, receptacle of a flower.

Thalloid, thallose, resembling a thallus.

Throat, the orifice of a gamopetalous corolla or calyx; the part between the proper tube and the limb.

Tomentose, densely pubescent with matted wool.

Torus, the thalamus of a flower.

Tri-, in composition, three or thrice.

Triandrous, having three stamens.

Trifoliolate, having three leaflets.

Trimorphous, occurring under three forms.

Truncate, ending abruptly, as if cut off transversely.

Tuber, a thickened and short subterranean branch having numerous buds or eyes.

Tubercle, a small tuber or tuber-like (but not necessarily subterranean) body.

Tuberous, having the character of a tuber; tuber-like in appearance.

Tumid, swollen.

Tunicated, having concentric coats, as an onion.

Turbinate, top-shaped; inversely conical.

Turgid, swollen, or tightly drawn, said of a membrane or covering expanded by pressure from within.

Umbel, an inflorescence in which the peduncles or pedicels of a cluster of flowers spring from the same point, which is usually embraced by an involucre of bracts.

Umbellate, in or like an umbel.

Umbellet, a secondary umbel.

Umbelliform, in the shape of an umbel.

Uni-, in composition, one.

Unisexual, of one sex, either staminate or pistillate only.

Urceolate, hollow and cylindrical or ovoid, and contracted at or below the mouth, like an urn.

Utricle, a small bladdery one-seeded fruit, pericarp loose, not adhering to the seed, as in ashere; any small bladder-like body.

Vallecular, of or near a valley or groove.

Valvate, in æstivation, meeting by the edges without overlapping.

Valvular, opening by valves, as a capsule.

Valve, one of the pieces into which a capsule splits.

Vascular, furnished with vessels or ducts.

Veins, threads of fibro-vascular tissue in a leaf or other organ.

Ventral, belonging to the anterior or inner face of an organ; the opposite of dorsal. Placenta is ventral when situated on the inside of the ventral suture, as in a legume.

Vernation, the arrangement of leaves in the bud.

Versatile (anther), attached near the middle and turning freely on the filament as on a pivot.

Verticil, a whorl.

Verticillate, disposed in a whorl.

Villous, bearing long and soft hairs.

Viscid, glutinous, sticky.

Vitta, an oil-tube; a structure commonly present in the pericarp of the *Umbelliferæ.*

Whorl, an arrangement of leaves, &c., in a circle round the stem.

Wing, any membranous or thin expansion bordering or surrounding an organ; the lateral petal of a papilionaceous corolla.

Zygomorphic, capable of division into two equal and similar halves by only one plane of symmetry; monosymmetrical.

Zygospore, product of conjugation.

Zygote, product of conjugation or fertilization; includes both zygospore and oospore.

INDEX

*NOTE – References to figures are entered thus, e.g. "Acacia, 56 fig 57", which signifies "figure 57 on page 56". The same method applies throughout the Index. Bengali names are in CAPITALS.